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Psychopathy and risk taking

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CHAPTER 1 –

Psychopathy and risk taking: A review investigating common underlying mechanisms.

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Introduction

Psychopathy, a multidimensional personality disorder (Sleep et al., 2019) is characterised by superficial charm, exploitative behaviour, callousness, impulsivity, and antisocial behaviour (Cleckley,1941/1955; Hare,2003). Due to these traits, psychopathy shows robust associations with adverse risk taking within both community (Hunt et al., 2005) and forensic samples (Swogger et al., 2010). Evidence suggests that individuals with elevated psychopathic traits make disadvantaged risky decisions even in the face of contradictory feedback (van Honk et al., 2002, Sutherland & Fishbein, 2017), and financial loss and punishment (Jones, 2014). Despite a peak in risk taking during adolescence (Defoe et al., 2015), adolescents with elevated levels of psychopathic traits show more risk taking behaviours compared with adolescents with low psychopathic traits or those with heightened impulsivity (Andershed et al., 2002; Dubas et al., 2017; Nijhof et al., 2011). Moreover, Dubas et al. (2017) showed that adolescents with heightened levels of psychopathic traits may be more likely to engage in risk taking earlier in adolescence. Furthermore, these adolescents are subsequently more likely to engage in serious risk taking trajectories later on in life.

Excessive risk-taking behaviours may include dangerous driving, risky sexual activities, illicit drug use, risky financial behaviour and criminal activity. These risky behaviours are associated with negative outcomes which can then persist into adulthood (Ciocanel et al., 2017). Excessive risk-taking behaviours may also result in short- and long-term health consequences, such as physical injury, disease, or even death (Dick & Ferguson, 2015; Vachon et al., 2018; Heron, 2017). In addition, risk taking is associated with increased levels of delinquency (Bui, 2014; Leas & Mellor., 2000). If these trajectories in turn result in irregular employment, prostitution (Edwards & Verona, 2016) or incarceration, worthwhile

opportunities later in life may be limited (Ullrich et al. 2008). When people face fewer legitimate opportunities, they may come to rely more on criminal behaviour to meet their needs (Dmitrieva et al., 2012)

In light of this, research has tried to understand why people with elevated levels of psychopathy engage in greater risk taking. If we can understand contributing factors, this may help to identify the most vulnerable individuals earlier and aid us in implementing preventative and treatment plans. To answer the question of why psychopathy is associated with high levels of maladaptive risk taking, research has started to explore underlying mechanisms and deficits associated with psychopathy that may render individuals at heightened risk for engaging in these behaviours. In search for these mechanisms, research has examined people's responses to threat and punishment (Hoppenbrouwers et al., 2016), their deficits in empathy (Lanciano & Curci, 2019) and attention (Ribes-Guardiola et al., 2020) and their potential neurobiological brain differences (Murray et al., 2018). However, psychopathy is not a unitary construct. It includes a constellation of traits including interpersonal, affective, and behavioural subdomains (Hare, 1996; Gillespie et al., 2019). These subdomains may be differentially associated with risk taking and may in fact have different underlying mechanisms for risk taking. Indeed, the use of global psychopathy measures is reductionist and overly simplistic (Andershed et al., 2018; Fanti et al., 2018).

Looking at relations between risk taking while separating psychopathy into subdomains as opposed to as a unitary construct may be useful for a variety of reasons. Firstly, as mentioned, it may be that some subdomains are differently or more associated with risk taking than others. Secondly, different subdomains may be linked to different forms of risk taking such as ethical versus health/ safety risk taking. Thirdly, the underlying processes and mechanisms driving maladaptive risk taking may not be the same for each subdomain. As psychopathy subdomains lie on a continuum (Ribeiro da Silva et al., 2019), the degree to

which different subdomains are present may differ from person to person. If distinct underlying deficits/mechanisms are associated with each subdomain, then individuals' motivations for engaging in risk taking may differ. For example, one person may engage in more risk taking due to poor impulse control and heightened reward sensitivity. Another person may engage in more risk taking because they cannot identify emotional expressions in other and they may also be fearless. Each will have formed mechanisms related to psychopathic traits, but each will be differentially related to the affective, interpersonal, and behavioural traits. Understanding the mechanisms could advance our knowledge of risk taking and help to explain contradictory findings within the literature whilst also developing better methods of assessment and intervention.

Accordingly, this paper has several aims: i) to review and synthesise the literature on the association between psychopathy subdomains and risk taking in both adults and adolescents, ii) to explore each psychopathy subdomain in relation to potential deficits and underlying vulnerabilities which may contribute to heightened risk taking propensity, iii) to consolidate the findings in relation to each of the three subdomains highlighting which pathways appear to show robust associations with heightened risk taking. iv) To identify any methodological issues that arose when evaluating the literature and highlight clinical implications in relation to psychopathy and risk taking. Finally, v) to address future recommendations and/or further directions within the field.

A narrative review is particularly useful to meet the specified aims because the intention is to make sense of the vast literature base, to integrate complex multidimensional themes and synthesise broad concepts together in a meaningful way. The present review was conducted by scouring the literature for any research on the association between risk taking and psychopathy. However, literature using global psychopathy measures alone were not included in the review, since we were interested in differential relations with the subdomains

of psychopathy. Secondly, the papers identified in the search were then examined for evidence of important individual differences factors and/or potential mechanisms that authors may have identified. Wider searches were then carried out to explore each potential mechanism in more depth. Literature was then collated to compare findings across various studies. Contextual risk factors such as the influence of peers and/or parenting or attachment relationships were not explored. Our purpose was to help increase understanding and specificity for the individual difference factors that might respond to interventions. Interventions could be targeted to strengthen or build up resources within the individual regardless of the contextual environment they live in. Building people's resilience factors may help them to make more adaptive choices. For the literature to be synthesised, there needs to be a way that comparisons can be made across different assessment tools, since psychopathy has been measured in varied ways.

Defining psychopathy and measures of assessment

Broadly, psychopathy constitutes interpersonal, affective, and behavioural features. However, there is controversy regarding how to optimally define and measure psychopathy (Miller et al., 2020). Table 1 outlines many of the most widely used or recently developed psychopathy measures for adults and adolescents. Cleckley (1941/1955) described psychopathy as "the mask of insanity" (Cleckley, 1976), formulating a set of traits that included both maladaptive (e.g. lack of remorse, egocentricity) and adaptive (superficial charm, lack of nervousness) traits. These were described by Cleckley based on his clinical observations (Sleep et al., 2019). Since then, a range of assessment tools have been developed. The Psychopathy Checklist-Revised (PCL; Hare, 1980) (PCL-R; Hare, 2003) is a clinically led interview, widely used in forensic populations. It is time consuming and labour intensive, therefore, adult self-report measures (largely based on similar conceptualisations of psychopathy) were developed. These included The Self-Report Psychopathy Scale (SRP,

SRP-II, SRP-III; Hare, 1985) and the Levenson Self-Report Scale (LSRP; Levenson, Kiehl, & Fitzpatrick, 1995).

The above conceptualisations of psychopathy were scrutinised for lacking in critical features included in Cleckley's (1976) original description. These included positive traits that disguised or provided a 'mask' for severe maladaptive traits. Thus, in contrast, the Psychopathic Personality Inventory (PPI/PPI-R; Lilienfeld & Andrews, 1996; Lilienfeld & Widows, 2005), the Triarchic Model of Psychopathy (TriPM; Patrick et al., 2009) and the Elemental Psychopathy Assessment (EPA; Lynam et al., 2011; Lynam et al., 2013) were developed. Although substantial debate still remains around the inclusion of traits such as 'Boldness' and 'Fearless Dominance' (see Lilienfeld et al., 2012, Miller & Lynam, 2012; Crowe et al., 2020; Miller et al 2020; Sleep et al., 2019), research papers using these measures were included within the review. The concept of psychopathy started out as a personality disorder in adults. However, it has been downward extended to adolescent samples since 2001. The Youth Psychopathy Inventory (YPI; Andershed et al., 2002) and the Antisocial Process Screening Device (Frick & Hare, 2001) have been developed and have been used widely.

Clark et al. (2019) proposed that subdomains from different measurement tools can be condensed into three main categories representing interpersonal, affective, and behavioural domains.

Grandiose Manipulation (interpersonal)

Individuals high on this subdomain are characterised by self-importance, grandiosity, fearlessness, remaining calm under pressure, satisfying their own self-interests and a continuous need to seek validation from others. In order to pursue their own personal gains, they may use manipulative, exploitative, deceitful, domineering methods. They may also use

their superficial charm or engage in pathological lying to meet their own needs (Fanti & Henrich 2015; Frick & Hare 2001; Međedović et al., 2017; (Jonason &Webster, 2012). These traits may also be useful if the person with psychopathic traits feels disrespected or challenged. Subdomains included under this heading tap behaviours/traits such as being manipulative, grandiose, fearless and bold but also include narcissism (see Table 1).

Callous-uncaring (Affective)

Individuals high on this subdomain are characterised by shallow emotions, are emotionally detached and are uncaring. They also lack in empathy. People who are high on the affective subdomain fail to show guilt or remorse for their actions, are often cruel to others to feel empowered and they appear to lack a social conscience (Kimonis et al., 2015; Pasion et al., 2018). Subdomains included under this heading tap behaviours/traits that include callousness, meanness and being uncaring (see Table 1).

Daring-impulsivity (Behavioural)

Characteristics of this subdomain include a tendency to be impulsive and to do things without thinking. People higher on the behavioural subdomain act with little reflection or forethought for the potential consequences of their actions. They are prone to boredom, exhibit high sensation-seeking (i.e., thrill seeking) and exhibit poor planning abilities (Salekin, 2016a, b). Subdomains included under this heading tap behaviours/traits such as being self-centered, impulsive and disinhibited, but also includes lifestyle and antisocial factors (see Table 1).

Table 1

Psychopathy measures and subdomains

Psychopathy										
Cleckley (1941/1955) Clinical observations- identifying maladaptive e.g. lack of remorse egocentricity and adaptive trait e.g. superficial charm, lack of nervousness										
THE PSYCHOPATHY CHECKLIST (PCL, Hare, 1980) Two Factor Model				**PSYCHOPATHIC PERSONALITY INVENTORY** (PPI/PPI-R; Lilienfeld & Andrews,1996; Lilienfeld & Widows,2005) Community samples						
FACTOR 1- Interpersonal/ Affective; callous-unemotional traits & grandiose-manipulative traits		**FACTOR 2**; Social deviance		**Fearless Dominance (FD)**		**Coldheartedness**		**Self Centred Impulsivity (SCI)**		
CU; Lack of empathy/uncaring, lack of remorse or guilt, unemotional, GM; Verbal and manipulative abilities, egocentricity, superficial charm, glibness		irresponsibility, prone to boredom, novelty seeking, antisocial behaviour		Fearlessness, Stress Immunity, and Social Influence		lack of interest in social or interpersonal issues		blaming others, carelessness, non conformity, ego driven behaviours		
THE PSYCHOPATHY CHECKLIST (PCL; Cooke & Michie, 2001) Three Factor Model				**TRIARCHIC MODEL OF PSYCHOPATHY** (TriPM; Patrick et al., 2009) Community Samples						
Factor 1: arrogant & deceitful	**Factor 2**; deficient affective experience	**Factor 3**; impulsive & irresponsible		**Boldness** (social dominance, persuasiveness, stress resilience, thrill-adventure seeking)		**Meanness** (callous, lacking empathy/remorse, coldheartedness, exploitative, emotional detachment)		**Disinhibition** (impulsive, poor planning, prone to boredom, impatient, irresponsibility)		
THE PSYCHOPATHY CHECKLIST REVISED (PCL-R; Hare, 2003) Four factor Model				**ELEMENTAL PSYCHOPATHY ASSESSMENT** (EPA, Lynam et al., 2011)						
Interpersonal (facet 1) grandiosity, superficiality, deceitfulness)	**Affective (facet 2)** callous, poverty of emotion, lack of empathy/remorse	**Lifestyle (facet 3)** impulsive, irresponsible, unfocussed lifestyle	**Antisocial (facet 4)** criminal and antisocial behaviour	**Narcissism;** arrogance, anger, self-assurance, dominance		**Antagonism** Callous, self-centred, manipulative		**Emotional Stability** invulnerability, unconcern, self contentment		**Disinhibition** Rashness, thrill-seeking, lack of persistence
self report measures (for adult community samples)										
SELF-REPORT PSYCHOPATHY SCALE (SRP-II; Hare, 1991).		**SELF-REPORT PSYCHOPATHY SCALE III (SRP-III; Paulhus et al., 2011)**								
Emotional Detachment	**Antisocial behaviour**	**callous affect (CA)**	**Interpersonal manipulation (IPM)**	**Erratic lifestyle (ELS)**	**Criminal tendencies (CT)**					
			manipulative, deceitful	rebellious, thrill-seeking, rule breaking						
THE LEVENSON SELF-REPORT PSYCHOPATHY SCALE (LSPS; Levenson et al., 1995)										
Primary Psychopathy		**Secondary Psychopathy**								
callousness, manipulation, selfishness, lack of caring)		failure to learn from mistakes, poor self control, impulsive, volatile or self-destructive								
self report measures (for child/adolescent community samples)										
YOUTH PSYCHOPATHIC INVENTORY (YPI; Andershed et al., 2002)				**ANTISOCIAL PROCESS SCREENING DEVICE (APSD) self-report version (Frick and Hare 2001).**						
grandiose/manipulative	**callous/unemotional**	**daring-impulsive or impulsive/irresponsible**		Grandiosity/ Narcissism		**Callous**		**Impulsive**		

Psychopathy and risk taking

To address the first aim of this review of identifying which psychopathy subdomain/s are most associated with risk taking, various studies were collated and summarised in Table 2. Examining these papers also allowed us to test which subdomains were most associated with specific types of risk taking. Thirty-eight studies were identified from the literature across four different forms of risk taking. These studies were not limited to a particular population and included both offender, clinical and community samples.

In total, twenty studies recruited adult population samples. Of those twenty studies, some studies recruited several different types of population groups to allow for comparisons to be made within the same study. Thus, within the twenty adult studies, seven were adult community samples, 15 were offender or ex offender samples and were two clinical inpatient samples. In total, five studies recruited community college or undergraduate samples. Regarding adolescent samples, there were twelve studies in total. Nine studies recruited from community adolescent samples and three from incarcerated offender samples.

Risk taking was grouped into four themes that were explored sequentially for associations with psychopathy subdomains. These included risky sexual behaviours (ten studies), alcohol and/or substance use (thirteen studies), gambling (ten studies) and the Balloon Analogue Risk Task (BART; Lejuez et al., 2007) (five studies). Firstly, we examined which psychopathy subdomain was most consistently associated with risk taking when all studies were considered together. Next, we examined the associations between psychopathy subdomains and each of the four forms of risk taking to assess whether specific types of risk taking are associated with particular subdomains of psychopathy.

Associations with psychopathy across all studies

Of the thirty- eight studies included within the review, the daring-impulsivity subdomain (behavioural) was associated with risk taking in the majority of studies (twenty-one studies). The Callous-uncaring (affective) subdomain was associated with risk taking in six studies and the grandiose manipulation (interpersonal) subdomain was associated with risk taking in seven studies. Next, risk taking was examined for each type of risk taking.

Risky sexual behaviour (RSB)

Ten studies investigated psychopathy in relation to risky sexual behaviours (RSB). All studies used self-report measures of RSB, with most studies including questionnaire items relating to unprotected intercourse (e.g. lack of condom usage), having sex with multiple people, having sex while intoxicated or under the influence of drugs or casual sex with strangers and/or high-risk partners (Turchik & Garske, 2009). Two studies investigated sex work or prostitution (Edwards & Verona, 2016; Richards et al., 2003).

Comparison of findings revealed interesting gender differences. Across five studies using a variety of samples including incarcerated adult offenders, adults, college students and adolescents (Edwards & Verona, 2016; Fulton et al., 2014; Richards et al., 2003; Ručević, 2010; Visser et al., 2010), women with elevated daring-impulsivity (behavioural) traits, were more likely to engage in RSB. Thus, women with a preference for novel and exciting experiences but are also impulsive and do not engage in much forethought of the consequences such as risk of pregnancy or sexually transmitted infections are more likely to engage in RSB.

In contrast, four studies found that adult or adolescent men with elevated callous-uncaring (affective subdomain) and/or grandiose manipulation (interpersonal) traits were more likely to engage in RSB (Edwards & Verona., 2016; Fulton et al., 2010; Thornton et al.,

2019; Visser et al., 2010). Fulton (2010) postulated that one reason for these gender differences may be that men with combined callous-uncaring (affective) and grandiose manipulation (interpersonal) traits may be more desirable to women because traits such as achievement, heroism and well-being are also related to these subdomains (Patrick et al., 2006) which women may find attractive. Therefore, men with elevated levels of these traits may have increased opportunities to engage in RSB. Also, some of the adverse consequences of RSB significantly affect women more than men such as unwanted pregnancy or infertility due to sexually transmitted infections (STI). Therefore, men with traits such as manipulation, a lack of empathy and a disregard for the feelings of others may care less about causing an unwanted pregnancy or passing on a STI (Anderson et al., 2017) as it does not impact them as much. Fulton (2010) also postulated that perhaps women with elevated grandiose manipulation (interpersonal) traits (as opposed to daring-impulsivity) would be more able to refuse to engage in RSB. Two studies support this explanation, finding that women with elevated callous- uncaring (affective subdomain) and/or grandiose manipulation (interpersonal) traits were less likely to engage in unprotected vaginal sex or engage in direct sex work (Edwards & Verona, 2016; Richards et al., 2003). It was hypothesised that women offenders or those with drug use histories with heightened traits associated with being exploitative, manipulative, deceitful and uncaring may be more able to find alternative means of income or access to drugs other than via RSB (Edwards & Verona, 2016).

However, one study did not find evidence of gender differences in relation to psychopathy subdomains and RSB (Ručević, 2010). Despite using a mixed adolescent sample, Ručević (2010) found that only daring-impulsivity traits were positively associated with RSB for both men and women (although much stronger associations were found in adolescent women). They suggested that the absence of gender differences may be due to the

low levels of psychopathic traits observed in this sample (as expected for community samples) and that possibly the adolescent grandiose manipulation (interpersonal) construct was not the same as the adult grandiose manipulation construct (Ručević, 2010). They also suggest that gender differences in psychopathy subdomains and associations with RSB may be a result of stereotypical gender biases when completing self-report measures.

Two studies did not appear to explore gender differences in the samples (Anderson et al., 2017; Kastner & Sellbom,2012). Anderson et al. (2017) found that callous-uncaring (affective) traits in both adolescent men and women were associated with a younger age to first have sexual intercourse and pregnancy. However, only callous-uncaring traits were explored. Thus, it is difficult to ascertain whether the other psychopathy subdomains would also show associations with RSB. There were also slightly more males than females in this sample (58.3% males) which may have accounted for some of the association. Developmentally, adolescents in general can be self-centred with poorly developed empathy skills (Seagrave & Grisso, 2002). Hormones are heightened, peer influence increases, and individuals are experimenting and beginning to learn about relationships. Therefore, the association between RSB and callous-uncaring traits may be a result of a developmental period rather than a psychopathy trait. Kaster & Sellbom (2012) found that in a mixed gender community sample of undergraduate students, both grandiose manipulation (interpersonal) and daring-impulsivity (behavioural) subdomains were positively associated with RSB (although this association was stronger for daring-impulsivity traits). Again, it is difficult to ascertain whether these two subdomains are both associated due to gender differences as this was not explored.

Finally, one recent study exploring RSB in a sample of male incarcerated offenders did not find any associations with psychopathy at the subdomain level (Reynold et al., 2020). However, when global psychopathy scores were observed, men with scores of 30 or above on

the Psychopathy Checklist Revised version (PCL-R; Hare, 2003) reported having approximately twice the number of sexual partners as those with low global scores and were less likely to use protection during intercourse. Possible explanations for the lack of findings between subdomains compared to other studies explored may be due to using all male offender sample. The only other study with this type of sample was Thornton et al. (2019) and only callous-unemotional traits were explored. Therefore, it is difficult to ascertain whether similar findings would have been observed if Thornton et al. (2019) had also included other subdomains. It is possible that inconsistencies in Reynolds et al. (2020) study was also due to offender samples having much higher rates of psychopathic traits than those in community samples and using a clinical interview tool rather than a self-report measure of psychopathy. Due to much lower psychopathy traits observed in community samples, Reynolds et al. (2020) suggest that community samples may have been measuring the association between externalising psychopathology and RSB as opposed to psychopathic traits.

In summary, despite some inconsistencies between studies, findings appear to show that women with elevated daring-impulsive (behavioural) traits are more likely to engage in RSB. In contrast, men with elevated callous- uncaring (affective subdomain) traits and/or grandiose-manipulation (interpersonal) traits in community samples may be more likely to engage in RSB. This association found in men does not appear to generalise to offender samples.

Alcohol/substance use

Next, alcohol and substance use were considered. Twelve studies investigated the association between psychopathy and drug and alcohol use or alcohol use alone. Three studies explored only one psychopathy subdomain (callous-uncaring). These studies will be

discussed first, with the remaining nine studies which include two or more psychopathy subdomains discussed after.

In a high risk and community control adolescent sample, both conduct problems and elevated callous-uncaring traits (individually and interactively) predicted the onset of tobacco, alcohol, and marijuana before grade 7 (Anderson et al., 2018). This was more pronounced for callous-uncaring traits. Only when conduct problems were absent did callous-uncaring traits predict alcohol misuse over the past year as well as substance use and tobacco use onset in the past month. This was more pronounced in adolescent boys than girls, although the interaction between callous-uncaring traits and sex did not reach significance. These findings were consistent with other research which found that high levels of callous-uncaring traits were associated with more diverse and severe drug usage (e.g. opiates, cocaine, ecstasy, hallucinogens) in a male adolescent offender sample (Baskin-Sommers et al., 2015). Similarly, Andershed et al. (2018) found that elevated callous-uncaring traits and future and stable substance use (post three year follow up) were positively associated. Perhaps, people that are uncaring and less emotionally responsive to the distress experienced by others (Marsh & Blair, 2008), combined with a heightened focus for rewards may be more driven towards alcohol and substance misuse with little regard for the consequences (Blair, 2013).

Although the previous studies are useful for informing whether callous-uncaring traits are associated with substance use, they do little for informing our understanding about association between substance use and other psychopathy subdomains. It is possible that other subdomains have more pronounced associations with substance use in comparison to callous-uncaring traits. Therefore, explorations across nine studies exploring two or more psychopathy subdomains with a variety of samples was conducted. In adolescent male offenders (Hemphill et al., 1994; Kimonis et al., 2012; Pasion et al., 2018; Walsh et al.,

2007), adolescent and adult community samples (Charalampous et al., 2019; Coffey et al., 2018; Hillege et al., 2010; Satchell et al., 2020), and a study comparing incarcerated, clinical and community samples (Sellbom et al., 2017) consistent findings emerged. In all the studies, daring-impulsive (behavioural) traits showed robust associations with substance use.

Two studies found associations between substance use and other subdomains in addition to daring-impulsivity (Coffey et al., 2018; Hillege et al., 2010). Coffey et al. (2018) found that both grandiose-manipulation (interpersonal) and daring-impulsive were both associated with substance use. One reason for this discrepancy may be that the psychopathy measure used in this study (TriPM) includes traits such as fearlessness, venturesomeness and self-assurance in the interpersonal subdomain. Although, Satchell et al. (2020) also used this psychopathy measure, they only investigated alcohol use. Therefore, it may be that these traits specific to the interpersonal domain of this psychopathy measure in addition to daring-impulsivity traits are associated with substance use. Within the literature, there is some contention about whether "boldness" (the interpersonal subdomain on the TriPM) is a core component of psychopathy (Sleep et al., 2019). Perhaps the reason why other studies did not find associations with the grandiose manipulation subdomain and substance use is because traits such as grandiosity, superficiality, manipulativeness characterise this subdomain on measures such as the Youth Psychopathic Inventory (YPI) and PCL-R. Hillege et al. (2010) found all subdomains to be associated with substance use, with the strongest association with the daring-impulsivity subdomain.

In summary, there appears robust evidence across various sample groups, types of substance use and psychopathy measure that the psychopathy subdomain daring-impulsivity (behavioural) is positively associated with substance and alcohol use.

Gambling

The association between gambling and psychopathy subdomains was explored in ten studies. Eight studies used the Iowa Gambling Task (IGT; Bechara et al., 1994). This task was designed to replicate decision making in real life. Participants are presented with four decks of cards (A, B, C and D) placed face down in front of them. They are required to make a series of card selections and can choose which of the four decks they want to make a selection from. As cards are selected and turned over, participants will either win or lose computer money (Dean et al., 2013). The aim is to gain as much computer money as possible. However, each of the four decks are associated with different risk/reward ratios. Decks A and B are deemed 'risky' because they produce both high rewards but also high losses. The rewards are placed at unpredictable intervals through the deck. Overall, these decks will produce a net loss. In contrast, the other decks (C and D) are less risky because overall they will give a net gain. The rewards in these decks are smaller than decks A and B but the losses are also smaller. Thus, in these decks there is a smaller immediate reward but high long term gain (Dean et al., 2013). In most versions of the IGT, there are 100 card selections (five blocks of 20 cards). As the participants do not know the risk/reward ratios of each deck, it is associated with decision-making under ambiguity (Bechara & Martin, 2004). However, it has been argued that card selections 41 to 100 can be considered decision making under risk (Sinz et al., 2008), since performance significantly improves as participants learn which decks are associated with rewards or punishments and/or immediate verses long term outcomes. Findings from studies investigating the IGT have yielded contradictory results.

Across four of the five studies with adult male incarcerated offenders, no significant associations were found between IGT and any psychopathy subdomains (Kuin & Masthoff, 2016; Lösel and Schmucker, 2004; Schmitt et al., 1999; Yao et al,. 2019). In contrast, Hughes et al. (2015) found that the antisocial subdomain was related to better performance on

the IGT. This was also supported by Bass & Nussbaum (2010) study with adult psychiatric inpatients. Possible explanations for the discrepancies between these two studies in comparison to those that found no association may be due to several factors. These include small sample sizes (60 male offenders and 45 psychiatric inpatients), different psychopathy measures (e.g. PCL:SV versus PCL-R), different samples (offenders versus psychiatric inpatients) and that Hughes et al (2015) informed participants that some decks were more advantageous than others. In addition, most studies using the IGT, participants made 100 selections over five blocks (consisting of 20 selections). In contrast, Hughes et al. (2015) used 150 selections over 6 blocks (consisting of 25 selections) which may have impacted results. Within the literature, there is also debate whether "antisociality" is a core subdomain (Cooke et al., 2007) or a behavioural manifestation and consequence of other core psychopathy traits (Cooke et al., 2004).

Some studies have also found reverse, findings that daring-impulsivity (behavioural subdomain) is associated with poorer performance on the IGT (Beszterczey et al., 2013; Dean et al., 2013). Again, these differences may be due to low powered studies (sample size of 26), mixed sex samples (versus male only) and community/ex-offenders versus incarcerated offenders.

Two studies explored gambling related problems in a mixed sex adolescent community sample using a self-report measure (Ručević, 2016) or risk taking in a gambling task in a mixed sex adult community sample (Maes et al., 2018) found similar results. Psychopathy subdomains associated with gambling in both studies were grandiose manipulation and daring-impulsivity. However, measures assessing gambling in these are likely to be distinctly different to the IGT which assessed decision-making under ambiguity rather than decision-making under risk.

In summary, findings relating specific subdomains to the IGT have yielded mixed findings. Most studies show that at least in male incarcerated offender samples, no subdomain is consistently associated with IGT performance. Therefore, the overall association between risk-taking behaviour as measured by the IGT and psychopathy is unclear.

Balloon Analogue Risk Task (BART; Lejuez et al., 2002)

Five studies investigated the association between the Balloon Analogue Risk Task (BART) and psychopathy subdomains. The BART is a computerised task measuring impulsive risk taking (Reynolds et al., 2006). Participants decide how many times to pump a balloon up (to obtain rewards) before it bursts. If the balloon bursts, all accrued rewards will be lost. Participants are told that the more the balloon is pumped up, the more likely that the balloon will burst. Thus, risk taking is measured by the number of pumps a participant is willing to give each balloon before taking the accrued rewards and the number of balloons that burst.

Synthesising the findings of these studies was challenging. This was because studies used different sample groups (adult male offenders versus mixed sex community samples) and four different measures of psychopathy used across the five studies. Some psychopathy measures are clinician interview based (PCL-R) compared to others that are self-report (TriPM, YPI). Some traits such as 'boldness' present in some psychopathy measures such as the TriPM are absent or underrepresented in other measures such as the PCL-R (Snowden et al.,2017). In addition, the SPR-II (used in Hunt et al., 2005 study) does not have strong psychometric properties (Derefinko & Lynam, 2006) nor do the subscales of the SPR-II

correlate well with those of the TriPM (Drislane et al., 2014). Consequently, these subscales may not be measuring the same psychopathy features. Therefore, it is unsurprising that results were inconclusive with some studies showing no association between the BART and psychopathy subdomains (Swogger et al., 2010; Cantifanti & Negen, 2018) and some finding that antisocial behaviour (Hunt et al., 2005) or the interpersonal subdomain (boldness) positively associated with risk taking on the BART (Snowden et al., 2017). Snowden et al. (2017) caution the use of a single BART score being interpreted as an absolute measure of risk taking given that contrary to expectations the male community sample in their study showed higher levels of risk taking (as measured by the BART) than the offender group.

In summary, it remains unclear whether psychopathy or any psychopathy subdomain is robustly associated with the BART, given the inconsistencies in findings across different studies and between offender and community samples within the same study.

Section Summary

Both risky sexual behaviours and substance/alcohol use show the most robust associations with the psychopathy subdomain daring-impulsivity (behavioural subdomain). Gender differences were found relating to risky sexual behaviours, with women more likely to engage in RSB if they had elevated daring-impulsivity traits. Men (community not in offender samples) appear to show heightened RSB if they had heightened callous-uncaring (affective) and/or grandiose manipulation (interpersonal) traits. Gender differences were not consistently observed in studies exploring substance/alcohol use and psychopathy subdomains. In contrast, neither the IGT (a measure of risk taking under ambiguity) nor the BART (a measure of real work risk taking behaviour) yielded consistent associations with a specific psychopathy subdomain.

Table 2

Psychopathy subdomains across various measurement tools and their relation to risk taking.

RISKY SEXUAL BEHAVIOURS						
Author	**sample information**	**Sexual risk taking measure**	**Psychopathy measure**	**Subdomain findings**		
Anderson et al., 2017 Longitudinal	*N*=683, grade 7 to 11, 41.7% female, community adolescents	Age that first had sexual intercourse (vaginal only), how often condoms are used, frequency of sexually transmitted infections occurrence.	**APSD (CU only)**	**callous/unemotional** CU traits significantly predicted the age of participants first sexual intercourse and pregnancy. Higher CU traits did not predict lack of condom use.		
Edwards & Verona, 2016	Study 1: *N*= 171,18-53 years (*M*= 31.01), 100% female; offenders Study 2: *N*=319, 18-62 years (*M*=34.79), 42.3% women, community with drug use histories	Prostitution or sex exchange (questionnaire or public record data)	**PCL:SV**	**Factor 1 (affective-interpersonal traits)** Study 2: significantly positively related to sex exchange in men (but not women). In women, affective interpersonal traits may be protective against indirect sex exchange.	**Factor 2 (antisocial-impulsive traits)** Study 1: Prostitution (women only) showed positive association with impulsive-antisocial over and above drug dependence	
Fulton., 2010	*N*=511, 18-46 years (*M*=20.24), 76% female, college students	Sexual risk survey (sex without a condom, number of partners. Frequency of sex).	**PPI-R**	**Coldheartedness** Did not predict risky sexual behaviour for men or women	**Fearless Dominance** Positive correlation to sexual risk survey scores (men only)	**self-centred impulsivity** Positive correlation to sexual risk survey scores (both men and women)
Fulton et al., 2014	*N*=77; 21.98 years; female college sample	Sexual risk survey completed over the past 6 months	**PPI-R**	**Coldheartedness** Not related risky sexual behaviour (RSB)	**Fearless Dominance** not related RSB.	**Self-centred impulsivity** Positively associated with risky sexual behaviours.

Kastner & Sellbom, 2012	*N*= 393, 17-56 years (*M*=19.35), 49% male, community undergraduate students	Hypersexuality and risky sexual behaviour.	**MMPI-2-RF**	**Fearless Dominance (FD)** Both facets were positively associated with risky sexual behaviour. Higher levels of hypersexuality were more associated with the combination of IA and FD factors.	**Impulsive Antisociality (IA)** Both facets were positively associated with risky sexual behaviour. IA was showed stronger positive associations with hypersexuality than FD. Higher levels of hypersexuality were more associated with the combination of IA and FD factors.	
Reynolds et al., 2020	*N*=179, 21-59 years (*M*=33.93), male, incarcerated offenders	Risky Sexual Behaviour-lack of protection during sex, total number of sexual partners (lifetime)	**PCL-R**	People with high psychopathy traits (PCL-R total score ≥ 30) reported more than 2x more sexual partners and less use of protection (condom usage) than people with low psychopathy traits. Specific subdomains yielded no significant associations		
Richards et al., 2003	*N*=126, *M* age= 32 years, Female incarcerated offenders (drug users)	HIV risk behaviours	**PCL-R**	**Factor 1 (affective-interpersonal traits)** Higher affective-interpersonal traits were associated with being less likely to engage in unprotected vaginal sex.	**Factor 2 (antisocial-impulsive traits)** Higher antisocial impulsive traits are associated with higher likelihood of having sex with a partner known to use drugs and known to be HIV positive.	
Ručević, 2010	*N*=706; 12-19 years (*M*= 15.94); 32% male; community	Risky sexual behaviour (e.g. sex at a young age, promiscuity, and prostitution	**YPI**	**callous/unemotional**	**grandiose/manipulative**	**Impulsive– Irresponsible** The only subdomain that was positively associated with risky sexual behaviours (particularly girls)
Thornton et al., 2019	*N*=1216; 13-17 years; males; incarcerated offenders	RSB- sexual risk outcomes; unprotected sex, casual sex	**ICU**	**CU traits only** Direct and indirect (via substance use) associations with unprotected sex and casual sex.		
Visser et al., 2010	*N*=198, 18-32 years (*M*=19.80), 49% male, adult community	Risky Sexual Behaviour; age of first intercourse, number of sexual partners and number of affairs.	**SRP-III**	**Callous- affect & Interpersonal Manipulation** Positively associated with number of sexual partners (men only)	**Erratic lifestyle and antisocial behaviour** positively associated with number of sexual partners (women only)	

ALCOHOL & SUBSTANCE ABUSE						
Author	**Sample information**	**Substance disorder Measure**	**Psychopathy measure**	**Subdomain findings**		
Andershed et al., 2018 Longitudinal 3 years	*N*= 996, *M* age at baseline =12.12, 52% female, community, Cypriot sample	Cigarettes, alcohol & illegal drugs	**APSD, ICU (for CU traits)**	**Callous-unemotional** not a significant predictor of significant future or stable substance use. All traits together were positively associated with future substance use (3 years later) and stable substance use.	**Grandiosity/ narcissism** All traits together were positively associated with future substance use (3 years later) and stable substance use.	**Impulsivity** All traits together were positively associated with future substance use (3 years later) and stable substance use.
Anderson et al., 2018 (7th grade to 2 years post high school)	*N*= 753, 42% female, substance use was measured at 12 through to 20 years, community, high risk and control sample	Tobacco, alcohol and marijuana use	**APSD (CU only)**	**Callous-unemotional** Both CU and CD predicted the age of onset of substance use (especially CU). CU only (in the absence of conduct disorder) predicted higher tobacco use (higher in boys) & marijuana over the past month and alcohol misuse over the last year (higher in boys at grade 7). Association between sex and CU traits was not significant.		
Baskin-Sommers et al., 2015	*N*=1,170, 14-18 years, male adolescent offenders	Substance use (9 substances over past 12 months)	**YPI (CU only)**	**Callous-Unemotional** High CU more likely than low/moderate CU to use larger variety of substances and are more likely to have higher levels of conduct problems (CP) High CU was related to substance use after controlling for CP.		

Charalampous et al., 2019	*N*=334; 14-19 years; 42.5% males; community	Alcohol Use Disorders Identification Test (AUDIT)	**YPI**	**callous/unemotional**	**grandiose/manipulative**	**impulsive/irresponsible** likely increase their dependence symptoms in six months' time regardless of their current dependence symptoms, their gender or their age
Coffey et al., 2018	*N*= 361; 19-83 years; 46.8% male; community	Alcohol use, illegal drugs such as crack, cocaine or heroin	**TriPM**	**Meanness**	**Boldness** Positively predicted drug and alcohol use	**Disinhibition** Positively predicted drug and alcohol use
Hemphill et al., 1994	*N*= 200, *M* age= 30.1 years, male incarcerated offenders	Alcohol and various illegal drugs e.g. tranquilizers, stimulants, cocaine	**PCL-R**	**Factor 1** Not significantly correlated to drug use or dependence		**Factor 2** Significantly positively correlated with drug use and dependence
Hillege et al., 2010	*N*= 740, 14-19 *(M* age=15.6), 47% male, community, Netherlands	drug and alcohol use	**YPI**	**callous/unemotional** significantly positively related to the frequency of drug use (boys and girls) and alcohol frequency (boys only).	**grandiose/manipulative** associated with frequency of alcohol use & drug use symptoms (girls)	**impulsive/irresponsible** Strongest association with frequency of alcohol use & drug use symptoms (boys)
Kimonis et al., 2012	*N*=373, 13-17 years (*M*=16.42), male adolescent offenders	Alcohol, marijuana, inhalants and other drugs	**YPI**	**callous/unemotional (CU)**	**grandiose/manipulative (GM)**	**impulsive/irresponsible (II)** Associated with more frequent substance use in the six months prior to incarceration. High II traits associated with greater likelihood of meeting a dependence disorder diagnosis while incarcerated.
Pasion et al., 2018	*N*=56, 18-60 years, all male adult forensic. *N*=48, 18-60 years, male community.	Past substance use	**TriPM**	**Meanness**	**Boldness**	**Disinhibition** Associated with past substance abuse

Satchell et al., 2020	*N*=349, 18-72 years (*M*= 27.18), 67% female, community	alcohol use disorders (AUDIT)	**TriPM**	**Meanness**	**Boldness**	**Disinhibition** associated with problematic alcohol consumption	
Sellborn et al., 2017	**Correctional sample** Men; *N*=616, 11-63 years (*M* age= 31.4). Women; *N*=215, 19-64 years (*M* age= 37.0). Incarcerated offenders (men and women)	problematic alcohol, marijuana, other drug, and prescription use.	**PPI, LSRP**	Overall: Gender did not moderate associations between alcohol/substance use and psychopathy subdomain. Disinhibition/ social deviance traits were mostly associated with alcohol and substance use. Correctional Samples Affective-interpersonal subdomain, especially fearless-dominance were more strongly associated with substance abuse in women compared to men.			
Sellborn et al., 2017	**Clinical sample** Men; *N*=792, *M* age= 33.4 years. Women *N*= 303, Mean age= 34.8 years	age that first used alcohol/drug use, frequency of alcohol/drug use	**MMPI-2-RF**				
Sellborn et al., 2017	**Community sample 1** Men: *N*=178, 18-43 years (*M* age= 20.6) Women: *N* =424, 18-48 years (*M* age= 19.9). University students	alcohol, marijuana, and drug abuse	**SRP-III**				
Sellborn et al., 2017	**Community Sample 2** Men: *N*=597, 18-45 years (*M* =19.7) Women: *N* =942, 18-53 years (*M* age= 19.4). University students	Alcohol (symptoms and consequences). Drug (symptoms and consequences)	**MMPI-2-RF**				
Walsh et al., 2007	*N*=399, 100% male, offenders	Substance use disorders (SUD)	**PCL-R**	**Affective**	**Interpersonal**	**Lifestyle** across categories of SUD, impulsive and irresponsible showed most consistent associations.	**Antisocial**
GAMBLING							
Author	**sample information**	**Gambling risk-taking measure**	**Psychopathy Measure**	**Subdomain findings**			

Bass & Nussbaum, 2010	*N*= 45 (87% male), adult psychiatric inpatients	Iowa Gambling Task (100 selections over 5 blocks of 20 cards)	**PCL-R- 2** (semi-structured clinical interview)	**Facet 1 (Interpersonal)**	**Facet 2 (Affective)**	**Facet 3 (Lifestyle)**	**Facet 4 (antisocial)** Higher antisocial traits are associated with higher IGT scores (better performance)
Beszterczey et al., 2013	*N* = 26, 22-51 years (*M* =26.52), male ex-offenders	Iowa Gambling Task (100 selections over 5 blocks of 20 cards)	**PCL-R** (semi-structured clinical interview)	**Factor 1 (affective & interpersonal)**		**Factor 2 (lifestyle & antisocial)** High factor 2 traits showed correlations with lower overall scores (block 4 & 5). Failure to learn from feedback and modify choices.	
Dean et al., 2013	*N*= 129; 18-27 years; 30.23% male; college students	Iowa Gambling Task	**LSPS**	**Primary Psychopathy (cold, affective & interpersonal traits)** Not associated with risky IGT		**Secondary Psychopathy (antisocial and impulsive traits)** Higher secondary psychopathy only was associated with higher risk choices (blocks 3-5)	
Hughes et al., 2015	*N*=80; 19-69 years (*M*=34.23 years); all males; (60 incarcerated offenders; 20 community control).	Iowa Gambling Task (150 selections over 6 blocks of 25)	**PCL:SV** (semi-structured clinical interview**)**	**Affective**	**Interpersonal**	**Lifestyle**	**Antisocial** Related to better performance on IGT (more advantageous choices in the learning phase)
Kuin & Masthoff, 2016	*N*= 119, adult male (18+ years) incarcerated offenders	Iowa Gambling Task (100 selections over 5 blocks of 20 cards)	**PPI-R**	**Fearless Dominance** No association	**Self-Centered Impulsivity** No association	**Colheartedness** No association	
Lösel and Schmucker, 2004	*N*= 49, *M* age= 33.24 years, male only adult incarcerated offenders	Iowa Gambling Task and intelligence	**PCL-R**	**Factor 1 (affective & interpersonal** No associations with IGT. IGT was not associated with intelligence level.		**Factor 2 (lifestyle & antisocial)** No associations with IGT. IGT was not associated with intelligence level.	
Maes et al., 2018	*N*=200; 18-30 years (*M*= 23.0); 41% male; community	Risk and Ambiguity Task (gambling)	**TriPM**	**Meanness** no association	**Boldness** associated risk taking (gain frames)	**Disinhibition** enhanced risk taking in a high-probability loss context	

Ručević, 2016	*N*=282; 14-19 years; (*M*=15.92); 52.5% males; community	Canadian Adolescent Gambling Inventory	**YPI**	**callous/unemotional** more severe gambling-related problems only in males, not in females	**grandiose/manipulative** more severe gambling-related problems only in males, not in females	**impulsive/irresponsible** more severe gambling-related problems only in males, not in females.
Schmitt et al., 1999	*N*=157, male only adult incarcerated offenders	Iowa Gambling Task (100 selections over 5 blocks of 20)	**PCL-R**	**Factor 1 (affective & interpersonal** No associations with IGT	**Factor 2 (lifestyle & antisocial)** No associations with IGT	
Yao et al., 2019	*N*= 65, 22-59 years (*M*=39.82), male only adult incarcerated offenders	Iowa Gambling Task (100 selections over 5 blocks of 20) Game of Dice Task (GDT; Brand et al., 2005) & intelligence were explored.	**LSRP**	**Callousness** No significant correlations with IGT. IGT and intelligence were not correlated.	**Egocentricity** No significant correlations with IGT. IGT and intelligence were not correlated.	**Antisocial** No significant correlations with IGT. IGT and intelligence were not correlated. **Correlated with GDT**
BALLOON ANALOGUE RISK TAKING (BART)						
Author	**Sample Information**	**BART/ and other measures**	**Psychopathy measure**	**Subdomain Findings**		
Centifanti & Modecki, 2013	*N*= 675, 16-20 years (*M* =16.9), 52% female, community	BART	**ICU**	**Callous-Unemotional** Males with higher CU traits were quicker to make decisions involving risks than lower CU traits (especially after punishment)		
Centifanti & Negen, 2018	*N*=657, 16-18 years, 52% female, community	BART & stoplight	**ICU**	**Callous-Unemotional** Elevated CU traits not associated with either BART or stoplight.		
Hunt et al., 2005	*N*= 80, 18.9 years, 62% female, community (college sample)	BART	**SPR-II**	**Emotional Detachment** no significant correlation	**Antisocial behaviour** Positive correlation to BART Global psychopathy scores correlated with risk taking on BART.	

Snowden et al., 2017	*N*= 73; 21-78 years; 100% male; offenders. *N*=81; 18-25 years; 49% male; community	BART	**TriPM**	**Meanness** Associated with BART explosions in correlations but not significant in regressions	**Boldness** Total psychopathy scores indicated higher risk taking on BART (largely due to high boldness scores). Male community sample took the most risks compared to the male offender or female community sample.	**Disinhibition** no evidence of an association with risk taking on the BART
Swogger et al., 2010	*N*= 119; 18-44 years (*M*=27.92); 100% male; offenders	BART	**PCL-R**	**Factor 1 (affective-interpersonal traits)** Not associated with BART or sensation seeking risk taking.		**Factor 2 (antisocial-impulsive traits)** Not associated with BART or sensation seeking risk taking.

Note: BART= Balloon Analogue Risk Task (Lejuez et al., 2002), BART-Y= adolescent version of the Balloon Analogue Risk Task (Lejuez et al., 2007), Decision making under risk: GDT = Game of Dice Task (Brand et al., 2005); Decision-making under ambiguity: IGT= Iowa Gambling Task (Bechara et al., 1994); ICRT= Irresponsible and criminal risk taking , SSRT= sensation-seeking risk taking. Adult psychopathy measures: PCL-R = The Psychopathy Checklist revised version (Hare, 2003), SPR-II= The Self-Report Psychopathy Scale Version II, SPR-III= The Self-Report Psychopathy Scale Version III, LSRP= the Levenson Self-Report Scale (Levenson et al., 1995), PPI-R= Psychopathic Personality Inventory Revised Version (Lilienfeld & Widows, 2005), TriPM= Triarchic model of psychopathy (Patrick et al., 2009), PPTS =Psychopathic Personality Traits Scale (Boduszek, Debowska, Dhingra,&DeLisi, 2016), MMPI-2-RF = Minnesota multiphasic personality inventory-2-restructured form (Ben-Porath & Tellegen, 2008) Adolescent Psychopathy measures; YPI= Youth Psychopathy Inventory (Andershed et al., 2002); APSD= Antisocial Process Screening Device self-report version (Frick and Hare 2001). ICU=Inventory of Callous and Unemotional Traits

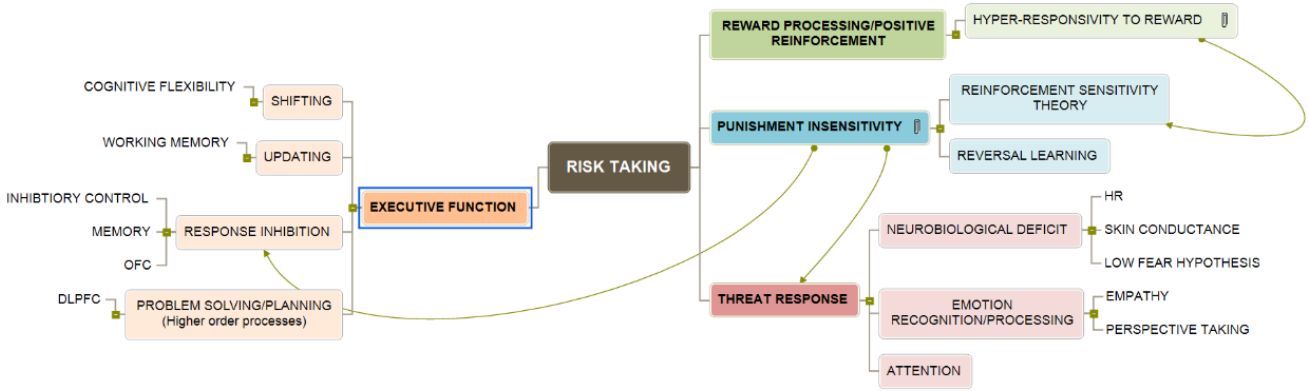
Underlying mechanisms and vulnerabilities

When deciding whether or not to engage in risk-taking, various processes may occur simultaneously. We examined individual difference factors that may make people more likely to take risks. Similarly, there may be deficits in processes that would typically hinder or prevent risk taking such as inhibitory control. Alternatively, there may be factors that disrupt reinforcement learning such that heightened risk taking is maintained even in the face of punishment or threat. To address the second aim of the review, mechanisms that may drive risk taking will be explored first. We will then consider which mechanisms which might prevent or hinder risk taking are impaired in people with psychopathy.

To add context, a person who is not bothered by punishments or the possibility of hurting others may take risks for personal gain. Thus, a deficit in threat processing or recognising emotions, a core part of empathy, may be related to risk taking. Empathy may be a potential mechanism by which people with affective psychopathy traits take risks. In contrast, a person that acts without thinking, is irresponsible, and disinhibited may be so focussed on potential rewards that they do not consider the negative consequences of their actions. Therefore, another possible reason for elevated risk-taking may be due to a failure to inhibit behaviours (Snowden et al., 2017). In addition, specific brain areas associated with reward sensitivity may be more responsive in people with behavioural psychopathy traits. Based on a review of the literature on risk taking, Figure 1 shows the known associated traits, neurobiological/neurophysiological findings, underlying behaviours, and behaviour management. I will take these in turn below and provide evidence for the associations.

Figure 1

Possible mechanisms linked to risk taking



Mechanisms involved in the pursuit of risk-taking behaviours

Hypersensitivity to rewards

The Ventral Striatum (VS) is a brain region that is thought to be involved in reward seeking, reward sensitivity and reward anticipation and consumption (Haber & Knutson, 2010; Knutson et al., 2000; Richards et al., 2013). It has been associated with the pursuit of rewards (Braams et al., 2015), increased risk taking on behavioural tasks (Blankestein et al., 2018) as well as risky behaviours in real life (Galvan et al., 2007; Braams et al., 2016). A systematic review found that the Ventral Striatum showed increased reactivity during the anticipation of rewards (rather than obtaining/consumption of rewards) in people with elevated daring-impulsivity (behavioural) traits (Murray et al., 2018). This suggests that in people with behavioural psychopathy traits, it is the "wanting" and possibility of obtaining the reward that is reinforcing rather than an extreme pleasure in obtaining the reward itself. However, other traits such as those from the interpersonal domain were not related to reward reactivity (Murray et al., 2018). Similarly, callous-uncaring (CU) traits (affective subdomain) have been explored with either no associations found between CU and reward

processing or non-significant effects once controlling for externalising behaviours (Byrd et al., 2018; Huang, 2019). This highlights that a hypersensitivity is specific to the behavioural psychopathy subdomain. In addition to mechanisms that may increase risk taking behaviours, there may be deficits in processes that would typically suspend reward- approach behaviour in people with psychopathy. These will be explored next.

Deficits in processes that might otherwise inhibit risk taking

Punishment insensitivity

Typically, the risk of punishment (risk of incarceration or harm to the self or others) acts as a strong deterrent against engaging in many risk taking behaviours, especially those that involve breaking the law and is the premise on which the criminal justice system is built. Response to punishment plays a crucial role in learning processes (through reinforcement) and decision making (Corr, 2004). Thus, an indifference or insensitivity to punishment may result in greater risk taking (Snowden et al., 2017). Unresponsiveness and/or insensitivity to punishment has been found in people with psychopathy (Lykken, 1995). Some authors argue that this is due to a failure to switch attention away from a particular goal driven behaviour despite negative feedback, known as response perseveration (Ribes-Guardiola et al., 2020). Therefore, behaviour that was previously rewarding is continued even in the face of increasing punishments that eventually outweigh the rewards (Ribes-Guardiola et al., 2020). This pattern of responding has been linked to daring-impulsivity traits (behavioural subdomain) in incarcerated men (Moltó et al., 2007), elevated callous-uncaring traits in children and adolescents (Frick et al., 2003; Roose et al., 2010) and interpersonal traits in men and women (Ribes- Guardiola et al., 2020).

A recent systematic review found callous-uncaring (affective) and grandiose manipulation (interpersonal) traits to be associated with reduced punishment reactivity (Murray et al., 2018) but not daring-impulsivity (behavioural) traits. In addition, teacher and adolescent ratings of punishment sensitivity also found callous-uncaring traits to be associated with a hyposensitivity to punishments (Allen et al., 2016). However, several studies failed to replicate these findings, showing no significant interactions between callous-uncaring traits and punishment processing (Byrd et al., 2018; Centifanti & Modecki, 2013; Huang et al., 2019; Platje et al., 2018). This is likely to be due to inconsistencies in the way that material used to measure punishment sensitivity. These have ranged from teacher reports (Allen et al., 2016), Monetary Incentive Delay Task paradigms (Huang et al., 2019), card guessing game (Byrd et al., 2018) and questionnaire measures (Platje et al., 2019) that make it difficult to make comparisons across studies.

Taken together, psychopathy subdomains relating to callous-uncaring (affective) and daring-impulsivity (behavioural) have yielded inconsistent and inconclusive findings. However, associations between grandiose manipulation (interpersonal) traits and punishment insensitivity appear more robust. This makes sense given that the subdomain is characterised by a sense of grandiosity, self-importance, and dominance. Another possible reason why people with psychopathy may fail to adjust their behaviour in the face of punishments may be due to a reduced fear reactivity to aversive or threatening stimuli.

Threat processing deficits

Given that high risk-taking behaviour has the potential for both high rewards and devastating negative consequences (e.g. injury and significant harm), when faced with threat, people usually experience anxiety or fear stimulating automatic physiological responses to prepare for danger. However, various studies have shown that offenders with high

psychopathic traits have an abnormal response when faced with aversive stimuli (Lykken, 1957; Newman et al., 2010; Verona et al., 2004). Some have theorised that people with psychopathy have a low fear response to aversive and threatening stimuli (Lykken, 1957; Hoppenbrouwers et al., 2016) which affects learning processes (Oba et al., 2019).

Within the literature there are mixed findings (Hoppenbrouwers et al., 2016), likely to be a result of varying methodologies in the way that fear is measured and conceptualised. A recent meta-analysis (Kozhuharova et al., 2019) of adult male offender samples found that both the affective and interpersonal subdomains were significantly associated with threat processing deficits. However, daring-impulsivity (behavioural subdomain) was not. Studies within the meta-analysis used a range of stimuli to induce and measure fear. These ranged from aversive shocks/noises to unpleasant images and measurement of fear included skin conductance, heart rate responses and startle responses (Kozhuharova et al., 2019). It is difficult to know whether these findings can be generalised to women and non-offenders given the sample restrictions. Also, the affective and interpersonal subdomains were combined, which makes it difficult to know whether deficits in threat processing are specific to both or only one psychopathy subdomain. Some authors have also criticised the use of physiological measures such as heart rate and skin conductance as measures of general arousal rather than fear specifically (Fanti, 2016). Thus, a series of studies have used the eyeblink startle reflex which is an involuntary and automatic defensive response to sudden stimulus.

Using this methodology, studies have found callous-uncaring traits (affective subdomain) to show hypo arousal to threat stimuli (Fanti et al., 2016; Fanti et al., 2017; Klingzell et al., 2016; Kimonis et al., 2017; Kyranides et al., 2016; Kyranides et al., 2017), whereas grandiose manipulative traits (interpersonal subdomain) was not associated to startle responses (Fanti et al., 2017; Kavish et al., 2019). Interestingly, daring impulsivity traits

were associated with hyperarousal threat responses. Support for threat processing deficits in individuals with elevated callous-uncaring traits was also found in a study using a white noise countdown startle response with a male adolescent offender sample (MacDougall et al., 2019). This suggests that callous-unemotional traits might be linked to fearlessness and an under reactive system in the face of threat, whereas daring-impulsivity (behavioural subdomain) may be linked to an over reactive threat system (Fanti, 2018). In addition to an under active threat response, individuals with heightened psychopathy traits may struggle to recognise fear cues in others. A failure to recognise fear in others may result in a lack of awareness of behaviours that make others afraid (Marsh & Cardinale, 2014). This may affect learning as facial feedback from others is not integrated and used to guide behaviour. Thus, this may be another important mechanism increasing risk taking behaviours.

Recognition of fear

There is overwhelming evidence that people with high levels of callous-uncaring traits (affective) have impairments in the ability to accurately identify the emotional states of others, especially fear. Across adult and adolescent community and offender samples findings consistently show that people with elevated callous-uncaring (affective) traits are worse at recognising fearful faces (Brislin & Patrick, 2019; Brislin et al., 2017; Dawel et al., 2012; Gillespie et al., 2019; Halty, 2019; Igoumenou et al., 2017; Moore et al., 2019). These findings are consistent even when different psychopathy measures are used and across different facial recognition stimuli. A deficit in the ability to process the distress cues in others has been argued to contribute to the development of callous-uncaring traits because feedback through social learning and moral development is impinged (Blair, 1995). This may also affect the development of empathy and perspective taking resulting in a lack of consideration of the impact that risk taking may have on others.

Studies have shown that people with elevated callous-uncaring traits have reduced cognitive and affective empathy (Kahn et al., 2017; Lanciano & Curci, 2019). Cognitive empathy is the ability to hold the perspective of another person to understand what they may be feeling (Kahn et al., 2017). Whereas affective empathy is the arousal felt in response to someone else's emotional state. Both are argued to be involved in the development of empathetic concern for other people (Kahn et al., 2017). Furthermore, emotional autobiographical memory deficits have been associated with people with callous-uncaring traits (Lanciano., et al 2019).

Thus, people that have high levels of callous-uncaring traits are less able to recognise fear in others, have poorer perspective taking abilities, lack empathy and are unable to recall emotional events accurately. Consequently, they are unlikely to be able to learn from previous experiences or be able to utilise or integrate important contextual cues when behaving or responding to situations. It is not surprising that these people may engage in risk taking behaviours without caring about the consequences to others. In contrast, people with daring-impulsivity traits do appear able to recognise fear in others, yet these traits are most associated with risk taking. One explanation may be linked to executive function abilities.

Deficits in executive function, particularly inhibitory control

Executive function is an umbrella term to describe a set of different processes that include abilities in shifting, updating and inhibition (Baliousis et al., 2018). Shifting is the ability to move flexibly from one task to the next and requires cognitive flexibility. Updating is the ability to monitor and encode relevant information. Therefore, it requires the ability to hold and manipulate information in working memory and replace and/or update information that is relevant (Baliousis et al., 2018). If the ability to acquire and update new information is impaired, a person will find it hard to learn from experience or feedback. Inhibition is the ability to stop a behavioural impulse or interrupt automatic responses. This requires a variety

of processes such as working memory, inhibitory control, shifting between information, planning and response reversal (Baliousis et al., 2018). This is particularly relevant to risk taking behaviour and the ability to consider future negative consequences as well as potential rewards. These three processes contribute to two higher order executive functions, planning and problem solving (Baliousis et al., 2018).

Various research has linked executive function abilities to risk taking. Lower executive function abilities have been linked to more dangerous driving such as speeding and driving whilst under the influence of alcohol. Impulse control was specifically linked to driving without a seatbelt (Hayashi et al., 2018). Increased polysubstance use has been linked to lower executive function abilities in adolescents (Gustavson et al., 2017), whilst older participants with poorer executive function abilities made more risky choices of risk-taking task (Brand et al., 2013).

Generally, daring-impulsivity traits (behavioural) have been associated with poorer global executive function abilities (Baskin-Sommers et al., 2015b), whilst the interpersonal and affective subdomain have been associated with normal or higher levels of executive function abilities (Bresin et al., 2014; Pera-Guardiola et al., 2016). In relation to specific executive function abilities, studies have shown that different subdomains are positively and negatively associated to performance.

In relation to shifting, the interpersonal subdomain has been associated with better performance (Sellbom & Verona, 2007), whilst the affective subdomain has been linked to poorer performance (Mahmut et al., 2008). Updating has also been positively associated with the interpersonal subdomain (Hansen et al., 2007; Sellbom & Verona, 2007). However, several studies have found that deficits in the ability to update and integrate new information are present in people with elevated levels of behavioural psychopathy subdomain (Carlson et

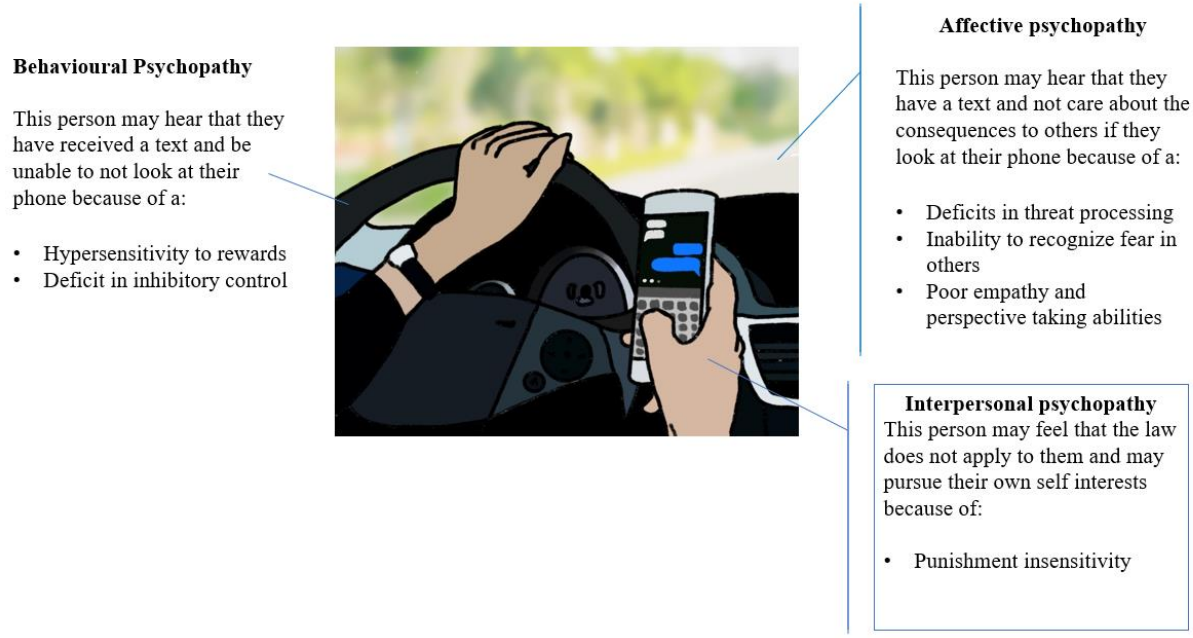
al., 2009; Carlson & Thái, 2010; Pasion et al., 2018; Sadeh & Verona, 2008). These people also have difficulties in the ability to inhibit behaviours (Feilhauer et al., 2012; Lantrip et al., 2016; Sellbom & Verona, 2007). In comparison, people that have elevated levels of interpersonal traits perform better on response inhibition tasks (Carlson and Thái, 2010; Feilhauer et al., 2012; Prata et al., 2019; Sadeh and Verona, 2008; Weidacker et al., 2017).

In summary, people that are callous and uncaring are unable to shift attention. In relation to risk taking, this may manifest as an inability to alter their behaviour despite the damage caused to other people. People who are grandiose, manipulative, and deceitful are able to shift flexibly in response to new information. They are also able to inhibit impulses. This may enable them to stay calm under pressure and in stressful contexts. These traits may be useful in some contexts and have been linked to "successful" psychopathy (DeMatteo et al., 2006). In relation to risk taking, they may take calculated risks that are less likely to result in incarceration. Finally, people who are impulsive, daring, thrill seeking and irresponsible have poor abilities to inhibit impulses nor are they able to update and integrate new information. Thus, these people may engage in repeated risk-taking behaviours without reflecting on the possible consequences of their actions.

Drawing this information together, it appears that the three psychopathy subdomains are associated with different underlying mechanisms that may heighten risk taking propensities. Figure 2 is a pictorial summary of the information in the previous section.

Figure 2

A pictorial diagram depicting a hypothetical scenario, different psychopathy subdomains and how underlying mechanisms may affect behaviour.



Although it is useful to explore each individual subdomain, it is unlikely that they will arise in isolation. Evidence suggests that certain subdomains appear to cluster together. Bergstrøm & Farrington (2018) found evidence that people with elevated affective traits (callous-unemotional) also appeared to have elevated behavioural traits (daring-impulsivity) but not interpersonal traits (grandiose-manipulation). They found that this group of people were the most impaired group with the highest levels of offending, convictions, drug abuse and substance problems. Similarly, Fanti et al. (2018) found that only adolescents with all three psychopathy subdomains scored within the clinical range for conduct disorder.

Methodological Considerations

When reviewing the literature, there are several methodological considerations that should be addressed. Firstly, there is a lack of consensus as to how psychopathy should be operationalised and how it should be measured. Several measures have been developed and some subscales do not correlate well with subscales on other measures (Drislane et al., 2014). For example, subdomains of the Self-Report Psychopathy Scale Version II (SRP-II; Hare, 1991) do not correlate well with those on the Triarchic Model of Psychopathy (TriPM; Patrick et al., 2009) which make comparisons across studies inherently flawed. Psychopathy measures are not consistent in the way they are administered, such that some use clinical notes and clinical interviews (e.g. PCL-R; Hare, 2003) by a trained clinician and commonly used in forensic samples. In comparison, other measures rely on participant self-report (e.g. SRP-III; Paulhus et al., 2011). Although self-report measures have the advantage of being quicker and easier to administer, participants may not provide honest or accurate reporting. Additionally, some models include more adaptive traits such as "boldness" (TriPM) to a greater extent than others (particularly the PCL-R) due to being developed from normal personality models (Baskin-Sommers et al., 2015). Even within the same measure, different revisions may capture different traits. For example, the third factor model of The Psychopathy Checklist Revised (PCL-R; Cooke & Michie, 2001) does not include most of the criminality items (in contrast to the two and four factor model). This suggests that antisocial behaviour/criminality is not part of the core features of psychopathy but is a behavioural consequence of other core traits (Delfin et al., 2019). This lack of consistency in the definition and measurement of psychopathy, also presents challenges within other constructs addressed in this review such as risk taking.

Risk taking is also multidimensional. Thus, a reliance on one measure of risk taking is argued to be narrow and misleading (Lejuez et al., 2017). Different tasks and/or self-report

measures designed to measure the same construct have been shown to lack consistency across and within studies (Blankenstein et al., 2018; Lorenz & Kray, 2019). Possible explanations for inconsistencies may related to different task characteristics. For example, changes in risk level versus static risk, known versus unknown/ambiguous risks, time pressure versus no time pressure, whether the task is based on previous experience and actual monetary gains versus hypothetical rewards may be some reasons (Lorenz & Kray, 2019). Therefore, tasks designed to measure the same construct may actually be measuring different aspects of risk taking. Some tasks have been condemned for lacking repeatability such as the Iowa Gambling Task (Lejuez et al., 2017), while the psychometric properties of other measures such as the Balloon Analogue Risk Task (BART) have been criticised (Steiner & Frey, 2020). Instead, tasks or self-report measures need to be clearly defined and categorised in terms of the aspects of risk taking that they target rather than broad comparisons made across tasks (Lejuez et al., 2017).

Risk taking has frequently been conceptualised as 'bad', with most literature focussing on the association between maladaptive risk taking and psychopathy. However, risk taking is more likely to be continuous, with each end of the spectrum being unhelpful and more adaptive risk taking in the middle (Lejuez et al., 2017). Some studies have even suggested risk taking is important for the development of specific skills and abilities (Luna & Wright, 2016; Murty et al., 2016). In addition to the challenges raised due to inconsistencies in the conceptualisation and measurement of constructs, exploration of cross-cultural differences is often lacking within the psychopathy literature. Much of the research to date has predominantly focussed on white males (Skeem et al., 2011) and the extent to which findings can be generalised to different ethnicities is unclear.

Although outside of the aims of this review, it important to assess to what extent cross-cultural differences play a role in risk taking and psychopathy. However, in order to do

this, it is important to assess the extent to which the construct of psychopathy and the measurement tools can be generalised across different ethnicities (Skeem et al., 2004). Evidence suggests that some measurement tools such as the Psychopathy Checklist-Revised (PCL-R; Hare, 1991), and are suitable across white and black adult samples (Skeem et al., 2004). Similarly, both the Levenson Self Report Psychopathy Scale (LSRP; Levenson et al., 1995) and the Inventory of Callous-Unemotional Traits (ICU; Frick, 2004) are suitable for use across adolescents that are Hispanic and black (Horan et al., 2015). However, the Psychopathy Check List: Youth Version (PCL:YV) is unsuitable for Hispanic adolescents (Jones et al., 2006).

Clinical Implications

Stigma and the diagnosis of "psychopathy"

Firstly, this review highlights how crucial it is to consider psychopathy as a multidimensional construct unique to each person rather than as a unitary construct. Focussing on the heterogeneity of psychopathy may help to avoid the detrimental effects of labelling someone as a "psychopath" (especially in adolescence) which can lead to incorrect assumptions and a reduction treatment access (Lynan & Gudonis, 2005). Given that two people with potentially the same diagnosis can present in very different ways regarding the type of risk taking behaviour they may engage in and what underlying mechanisms may drive these behaviours, the diagnostic label does little for understanding the nuances relevant to each specific person. Moreover, research has found that even amongst professionals, people with high psychopathy scores can be viewed in a stereotyped manner. This is problematic as it can lead to blanket policies being implemented or assumptions about the treatability and criminal tendencies (Skeem et al., 2011).

Alarmingly, Edens et al (2003) found that participants reviewing case vignettes in a newspaper article were significantly more likely to support juvenile capital murder when the defendant had a diagnosis of psychopathy. Participants were also more punitive towards black versus white defendants (Edens et al., 2003). Furthermore, a meta-analysis of ten juror simulation studies found that defendants viewed as more psychopathic were more likely to be viewed as dangerous evil, were given longer sentences and stronger support to be given death sentences (Kelley et al., 2019). This highlights some of the adverse consequences that can arise when global labelling is applied.

The impact of risk taking

This review showed that the people with daring-impulsive psychopathy traits are more likely to engage in risk taking, particularly risky sexual behaviours (in women) and substance use. Short- and long-term consequences of engaging in these risky behaviours include, pregnancy, contracting sexually transmitted infections and substance dependence. These can impact life trajectories (especially in adolescents) affecting engagement in education, limited academic qualifications leading to limited job opportunities and possible financial instability. Individuals may resort to more increased risk-taking behaviours in order sustain established drug habits or as a means of income.

Women with daring-impulsivity traits that become pregnant may be more likely to provide unstable environments, which may negatively impact the mental health of their children (Beaver et al., 2014). This is especially pertinent given that Belsky (1984) argues that parental personality is the most important factor in a child's outcome. In addition, insufficient supervision and inconsistent parenting have been linked to children engaging in more risky sexual behaviour and substance use (Donenberg et al., 2002). Therefore, it is imperative to identify people who most vulnerable to engage in high risk behaviours and

provide early interventions. In a systematic review, Hale et al. (2014) provided some evidence that interventions for adolescents can be effective for substance use, however the extent to which this can be generalised to individuals with elevated levels of daring-impulsivity traits is unknown.

Risk of victimisation due to risk taking

The risk of victimisation has been linked to psychopathy (Daigle et al., 2020). Possibly due to deficits in fear reactivity, people with elevated psychopathy may be less attuned to environmental signals of threat and risk (Daigle et al., 2020). A lack of inhibitory control coupled with greater sensitivity to rewards may tempt people to pursue rewards despite the high risks. As a result, these people may continuously place themselves in high risk situations or engage in high risk behaviours. High risk environments are more likely to attract motivated offenders and increase the risk of victimisation (Daigle et al., 2020). In addition, possibly due to their emotional deficits, individuals with elevated psychopathy traits are less likely to form supportive peer relationships (Muñoz et al., 2008) or strong attachment bonds (Schimmenti et al., 2014) that may otherwise be protective (Muñoz et al., 2008). More-over a recent a meta-analysis highlighted that the behavioural subdomain characterised by impulsivity and irresponsibility was positively associated with delinquency in adolescents (Geerlings et al., 2020). Adolescents involved in the justice system show higher rates of trauma exposure and posttraumatic stress symptoms (Kerig & Becker, 2012), which in turn has been associated risky sexual behaviours (Weiss et al., 2013) and substance misuse (Weiss et al., 2015)

Treatment and intervention

The treatment of offenders with psychopathy have shown relatively ineffective results (Olver et al., 2013 Salekin et al., 2010), however, one reason may be that treatments do not

target the unique deficits specific to subdomains. As evidenced in this review, individuals high on affective and interpersonal traits show a deficit in threat processing and are thus are unlikely to learn and change their behaviour through the use of aversive learning or punishments (Kozhuharova et al., 2019). However, treatments designed to target deficits such as remediation training (Baskin-Sommers et al., 2015) have shown more successful results.

Some traits as adaptive?

The review highlights that not all subdomains show consistent associations with risk taking behaviour. Therefore, psychopathy in itself may not be a risk factor for risk taking behaviour but moderated through deficits in other processes such as executive functions (Ishikawa et al., 2001). "Successful Psychopaths" are non-criminal individuals often in high powered jobs such as CEOs, politicians and physicians and characterised by psychopathic traits such as egocentricity, superficial charm and irresponsibility (Gao et al., 2010). Better executive functions have been observed in successful psychopaths with elevated interpersonal- affective traits (De Matteo et al., 2006) and lower behavioural (daring-impulsivity) traits (Ishikawa et al., 2001). Therefore, some psychopathy subdomains (interpersonal and/or affective) may be adaptive and even beneficial in some contexts enabling emotional resilience, calmness under pressure and high stress and perseverance (Pasion et al 2018). These individuals may be able to pursue goals using strategies that are less likely to result in incarceration (Gao et al., 2010).

Not all risk taking is bad

Although this review largely focusses on maladaptive risk-taking behaviour, engaging in risk taking behaviour per se is not always "bad". For example, individuals with high psychopathic traits, especially "boldness" traits have been linked to more positive forms of

risk taking such as heroism (Patton et al., 2018). In specific contexts, traits such as fearlessness of threat or punishment may be useful such as NHS staff working amidst a global pandemic or engaging in public protests in order to bring about social change (black lives matter). Importantly, some research has shown that some of the same traits associated with maladaptive risk taking such as sensation seeking are also associated with positive forms of risk taking (Duell & Steinberg, 2019). Therefore, a more pertinent avenue may be not in reducing risk taking but to try and channel high risk-taking propensities in individuals with high psychopathic traits towards more positive means.

Future Recommendations/Directions

Within the adolescent literature, the association between psychopathy subdomains and risk taking has been dominated by a focus on callous-unemotional traits alone (Fanti et al., 2018). Therefore, it is crucial that more research is conducted investigating all psychopathy subdomains in relation to risk taking using multiple risk-taking measures (Blankenstein et al., 2018). Given that risk taking can be both maladaptive and positive, it would be important to investigate which psychopathy subdomains are associated with more positive forms of risk taking. By exploring possible mechanisms between subdomains and positive risk taking, this could help to guide more effective interventions. As discussed previously, people with elevated psychopathy traits tend to present with multiple subdomains traits. Thus, it would be important to explore how the interaction or combination or multiple subdomains is associated with risk taking behaviour.

Another avenue could be to explore the association between parenting, risk taking behaviour and psychopathy. This may be important given that parenting quality can increase risky sexual behaviours and substance use (Donenberg et al., 2002) and that harsh parenting

has been linked to the affective subdomain (callous-unemotional traits) (Waller & Wagner, 2019). Although the focus of the review was to explore underlying mechanisms that may explain associations between subdomains and risk taking, it is possible that for some individuals risk taking is adaptive (from an evolutionary perspective). Therefore, understanding people's motives (e.g. a reaction to vulnerability, a way to obtain something or for the risk behaviour itself) and how this links to self-identity may be important for understanding why people take risks (Zinn, 2019).

Conclusion

In summary, the review highlights that the use of global psychopathy measures are an inaccurate way to assess risk taking behaviours. Not all subdomains are equally associated with risk taking nor do they have the same underlying mechanisms driving behaviours which will have implications for treatment interventions. The behavioural psychopathy subdomain was most consistently associated with risk taking generally and specifically associated with risky sexual behaviours (for women) and substance/ alcohol use. The interpersonal subdomain appeared to be associated with risky sexual behaviours in men and the affective subdomain was shown to be associated to risk taking in some studies although not consistently so. Different underlying mechanisms appear important in driving risk taking behaviours. Hypersensitivity to rewards and deficit in inhibitory control appear important for people with elevated behavioural psychopathy traits. Deficits in threat processing, an inability to recognise fear, have empathy or perspective take are important in driving risk taking in people with elevated affective psychopathy and punishment insensitivity appear important for people with high levels of interpersonal psychopathy. Methodological issues, clinical implications and future directions have been discussed.

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CHAPTER 2 -

Exploring the relationship between psychopathy and risk taking in community adolescence: The role of risk skill

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Abstract

Introduction: The association between psychopathy and maladaptive risk-taking is well documented. However, unanswered questions remain as to why some individuals with high psychopathic traits do not engage in risk taking and may even channel this to more positive means. To date, no known research has investigated whether the ability to make consistent and strategic decisions about risks might be a 'risk skill' that is related to psychopathy. Skilled risk taking might also explain why some people with psychopathy fail to show high levels of maladaptive risk taking.

Aims: The present cross-sectional study investigated i) whether different psychopathy subdomains are associated with risk skill, ii) whether associations with risk taking might depend on which psychopathy subdomains are elevated, and iii) whether risk skill acts as a moderator in the association between psychopathy subdomains and various aspects of risk taking.

Method: Three hundred and thirteen adolescents (% female = 69, mean age = 16.70, SD =0.704) from seven schools were recruited between October 2019 and January 2020. Risk taking measures consisted of the Stoplight task and Adolescent Risk-Taking Questionnaire (ARQ). Psychopathy was measured using the Youth Psychopathic Inventory (YPI).

Results: Impulsive/irresponsible psychopathic traits showed associations with multiple measures of risk taking. Risk skill ability was associated with grandiose/manipulative traits but did not act as a moderator in any associations.

Conclusion: Early identification of adolescents with high impulsive/irresponsible traits may be important for promoting early intervention programs and skill development. This may help to channel high risk-taking propensities towards more positive means. Further research

is required to understand the potential indirect role of risk skill ability on psychopathy and risk taking.

Key words*:* psychopathy, risk taking, risk skill, adolescents, community

Introduction

Risk-taking propensity is associated with psychopathy in both adults and adolescents. Studies using a variety of techniques, including task-based and self-report risk taking measures show that psychopathy is related to risky behaviour. For example risky sex (Reynolds et al, 2020; Ručević,2010), dangerous driving (Endriulaitienė et al., 2018), gambling (Ručević, 2016), maladaptive financial behaviours (Costello et al., 2019) and alcohol/substance use (Andershed et al., 2018; Charalampous et al., 2019). However, not all individuals displaying psychopathic traits in childhood go on to offend (Frick et al., 2014) or engage in criminal risk taking (Costello et al., 2018). Psychopathic traits can conversely be related to more prosocial and positive risk taking such as heroism (Lykken, 1995; Patton et al., 2018; Smith et al., 2013), professional success (Eisenbarth et al., 2018) leadership roles (Landay et al., 2019) and creativity (Galang, 2010; Galang et al., 2016).

To serve the goal of channelling people with high psychopathy traits towards more positive outlets, it is important that we gain further insight into the complex association between psychopathy and risk taking. The primary aims of the present study are to examine whether risk skill ability, a pattern of behaviour where risks are evaluated and chosen in a consistent and predictable manner is associated with psychopathy and whether it is a potential moderator in the association between psychopathy and risk taking. The secondary aim is to further examine if specific subdomains of psychopathy (grandiose/manipulative, callous/unemotional and impulsive/irresponsible) are related to risk taking to see if a particular psychopathy profile is a better way to predict risk taking.

Psychopathy

Psychopathy is a multifaceted personality trait, characterised by a constellation of interpersonal, affective and behavioural features, such as social dominance, inflated sense of importance, lack of empathy, and impulsive behaviour (Frick & Marsee, 2018; Hare, 1996; Patrick et al., 1993; Walker & Jackson, 2017). Within the adult literature, there is a lack of consensus surrounding the conceptualisation of psychopathy. As a result, several measures of psychopathy have been developed. Broadly, these include interpersonal, affective, and behavioural subdomains. In adolescence, psychopathy is primarily identified as three etiologically distinct but interrelated subdomains (Salekin, 2017). These map onto adult subdomains and are named Grandiose/Manipulative (interpersonal), Callous/Unemotional (affective) and Daring/Impulsive or Impulsive/Irresponsible (behavioural) (Salekin, 2017). The construct of psychopathy is primarily an adult research diagnosis that has been extended downwards to childhood and adolescence to aid our understanding of its development (Cleckley, 1941/1976; Cooke & Michie, 2001; Fanti et al., 2018; Hare, 1991; Salekin, 2017).

Much of the adolescent and child psychopathy literature has focussed on callous/unemotional traits alone with less emphasis placed on grandiose/manipulative or impulsive/irresponsible traits. This has resulted in these subdomains largely being underrepresented within the adolescent psychopathy literature (Fanti et al., 2018). Although callous/unemotional traits have been considered a precursor to later psychopathy in adulthood (Frick, 2009), recent evidence indicates that using the multidimensional psychopathy construct is a superior predictor of future and stable antisocial behaviour (Andershed et al., 2018). As a result, it will be important to examine all psychopathy subdomains in relation to risk taking.

The development of specific traits in adolescence may render some individuals more vulnerable or susceptible to engage in dangerous risk taking than others depending on which psychopathy subdomain/s are elevated. If we can identify the most vulnerable individuals in adolescence then targeted and effective interventions could be designed and implemented before negative life trajectories have been established (Vachon et al., 2018). This is particularly important given that research indicates that interventions appear more successful if they are delivered early (MacDougall et al., 2019). If potential variables that moderate the relationship between psychopathy and risk taking, such as risk skill can be identified, this could be useful in helping adolescents become better at making decisions about risk. Heightened propensities for risk taking could be utilised in a positive way by channelling behaviours towards more adaptive or positive risks. Therefore, it is crucial that research using adolescent samples continues to advance in order to gain a better understanding of the potential underlying mechanisms that lead to heightened risk taking. However, caution has been raised about exploring psychopathy in adolescent samples given that this is a time when the brain and personality are still developing (Seagrave & Grisso, 2002).

Holding a developmental perspective

As psychopathy traits lie on a continuum (Marcus et al., 2012; Ribeiro da Silva et al., 2019) and are dimensional rather than discrete, research has been able to extend into non-clinical samples (Somma et al., 2018). As such, psychopathy traits have been found to be present to varying degrees in community, clinical and offender samples. Thus, it is crucial to hold a developmental perspective when using adolescent samples given that psychopathic features (to some extent) are considered normative and transient in this age group (Crone & Dahl, 2012; Seagrave & Grisso, 2002; Van Duijvenvoorde et al., 2016).

Behaviours common in adolescents such as egocentrism, self-centredness, and immature empathy skills (Seagrave & Grisso, 2002) could easily be mistaken as grandiose/manipulative or callous/unemotional traits. Similarly, adolescents are often irresponsible, lack planning (Salekin & Frick, 2005) and struggle to think of the potential consequences to their actions (Shulman et al., 2015). They also seek out new and exciting experiences (Duell et al., 2016; Romer & Hennessy, 2007; Spear, 2000). It is well established that heightened risk taking peaks during adolescence, possibly due to increased opportunities (Defoe et al., 2015). Despite these considerations, there is still a small subset of adolescents that display psychopathic traits outside of the normative range and engage in persistent and excessive levels of risk taking that continue into later life (Moffitt, 2018).

Although the stability of psychopathy has been contested (Cauffman et al., 2016; McCuish & Lussier, 2018), some research shows that heightened levels of psychopathy in childhood or adolescence will persist into adulthood and continue to influence decision making and behaviour (DeLisi et al., 2020; Lynam et al., 2009; Vachon et al., 2018). Decisions made in adolescence are important, therefore, if certain individuals are more vulnerable to poor decision making, we should try to understand what mechanisms might be involved in risk taking in order to prevent adverse consequences later in life. However, if risk taking is to be examined, it is important that the concept is fully understood.

Risk-taking and risk perception

Risk taking itself is complex and requires the consideration of multiple factors. Firstly, is there the potential for both reward and cost? Secondly, what is the discrepancy in value between reward and cost? Thirdly, what is the level of uncertainty of the outcome? Consequently, the riskiest option is the one with the greatest variability in reward versus cost

and the most uncertainty as to what the outcome would be (Figner & Weber, 2011; Holton, 2004).

Measuring risk taking can be difficult and we would argue that the best method is to use multiple measures, including both self-report and risk-taking tasks. Self-report is a tool that can be influenced by different cultural norms of risk taking and various opportunities to engage in risk (Duell et al., 2018). Therefore, to minimise these limitations, task-based paradigms have been developed. However, tasks designed to measure the same construct have nevertheless yielded different results, even within the same sample (Duell et al., 2018; Lorenz & Kray, 2019). Researchers have also found that self-report and task-based paradigms only correlate weakly (Blankenstein et al., 2018). Therefore, researchers have raised the importance of using multiple measures of risk-taking (Blankenstein et al., 2018), based on the idea that different paradigms are measuring different risk taking constructs.

A related, yet distinct construct to risk taking is risk perception which has also been found to be associated with psychopathy within the literature. Making a judgement about the likely risks versus costs is referred to as risk perception. Research indicates that individual risk perceptions vary depending on the type of risk measured e.g. health versus social risks (Blais & Weber, 2006). Further, risk perception appears to be an important mediator in the relationship between specific psychopathy subdomains and different types of risk taking (Hosker-Field et al., 2016). In undergraduate students using an adult psychopathy measure, risk perception mediated the relationship between callous affect and interpersonal manipulation with ethical risk taking. Hence, students displaying higher callous affect and interpersonal manipulation traits were more likely to report greater levels of ethical risk taking but only when perceiving these risks to be low. Similarly, students with higher erratic lifestyle traits (such as impulsivity, irresponsibility) were associated with greater health/safety and recreational risk taking but only when perceiving these to be low risk.

Typically, the concept of risk taking holds negative connotations, but not all risk taking is considered to be maladaptive.

Despite being associated with various adverse consequences such as unwanted pregnancies, sexually transmitted infections, addiction, increased mortality, and incarceration (Dick & Ferguson, 2015; Vachon et al, 2018), evidence suggests that in some contexts risk taking is adaptive and important for development. Two obvious ways in which risk taking could be adaptive is the development of autonomy and self-sufficiency (Luna & Wright, 2016; Murty et al., 2016). Therefore, a necessary question may not be about reducing risk-taking behaviours per se but about focusing it towards more positive avenues.

Risk taking and psychopathy

Broadly, psychopathy and risk taking are related and collectively, research indicates that the reliance on global measures of psychopathy is overly simplistic (Fanti et al., 2018). Specific interaction effects among discrete psychopathy subdomains have been explored in relation to different types of risk taking. The differential-configurations model (Lilienfeld et al., 2015) argues that the unique configuration of psychopathy subdomains may lead to varying expressions and consequences. These may help to distinguish successful from unsuccessful psychopathy (Bronchain et al., 2019). Narrower facets of psychopathy are often more related to specific outcomes than psychopathy overall, lending plausibility to the hypothesis that specific psychopathy subdomains will be more predictive than an overall score.

Interpersonal, affective, and behavioural subdomains have differentially been linked to risk taking and decision making (Maes et al., 2018; Satchell et al., 2018). For example, the behavioural and interpersonal subdomains show more reliable associations with risk taking

than the affective domain (Charalampous et al., 2019; Ručević, 2016; 2010; Yao et al., 2019). Research with community undergraduate students shows that students with higher erratic lifestyle traits (similar to impulsive/irresponsible subdomain of the Youth Psychopathy Inventory) had a greater proclivity for risk taking across various contexts such as ethical, financial, social, health/safety and recreational domains. However, other traits such as callous affect showed only indirect associations with ethical risk taking through lower risk perception (Hosker-field et al., 2016). Other research found no association between callous/unemotional traits and behavioural task-based paradigms of risk taking (Andershed et al., 2018; Centifanti & Negen, 2018). Some research shows there are interaction effects among subdomains over and above the main effects alone (Fanti et al., 2018; Somma et al., 2018). Thus, across adult and adolescent literature, the behavioural or impulsive/irresponsible subdomain appears to be the most consistently associated to risk taking directly, while other factors such as risk perception show mediating effects. However, not everyone with high levels of psychopathy will engage in maladaptive risk taking. Some people may find the anticipation of reward most valuable whereas others might be very good at planning and may capitalise on having a strategy.

Risk skill and psychopathy could plausibly be related because psychopathy is connected to concepts that could be related to risk skill, such as executive function. Certain people may be high on specific psychopathy subdomains that are related to higher intelligence and good executive functioning. These people may be able to plan effectively and therefore, remain consistent in their choice. Research from adult samples show that higher interpersonal traits are associated with better performance on measures of general intelligence, working memory and processing speed whilst both the affective and antisocial traits were negatively associated with general intelligence (Thomson et al., 2020). In addition, adults that scored higher on affective traits had lower working memory and had

slower processing speeds (Thomson et al., 2020). Similarly, greater verbal intelligence has been linked to interpersonal subdomains (Salekin et al., 2004; Vitacco et al., 2005), while behavioural and lifestyle subdomains (impulsivity, irresponsible and unfocussed lifestyle) have been associated with poorer verbal intelligence (Vitacco et al., 2005).

Different subdomains have also been related to various aspects of executive function. Poor planning and problem-solving difficulties and deficits in switching attention have been associated with impulsive-antisocial subdomains (Bagshaw et al., 2014; Baskin-Sommers et al., 2015; Delfin et al., 2018). These people may lack the ability to effectively integrate important contextual information into their decisions about engaging in risk taking. In addition, deficits in response inhibition have also been linked to impulsive-antisocial subdomains (Feilhauer et al., 2012; Lantrip et al., 2016) compared to interpersonal and affective subdomains where deficits have not been observed (Prata et al., 2019; Weidacker et al., 2017). This kind of consistency in decision-making could be useful: The idea that a professional poker player takes risks but is very planful and consistent may come to mind. They have adapted their risk taking in gambling so that they are potentially more successful. Thus, we need to know how psychopathy dimensions might relate to consistency in risk taking to understand adaptive versus maladaptive risky decisions.

If there is an association between different psychopathic subdomains and risk skill ability, this may help to explain why some subdomains are more reliably linked to risk taking than others. It may also guide more effective interventions by teaching people to be more skilled when making decisions about risk.

The present study

Being better skilled at risk taking could be one avenue by which those with higher levels of psychopathic traits could avoid taking dangerous risks. We examine that possibility

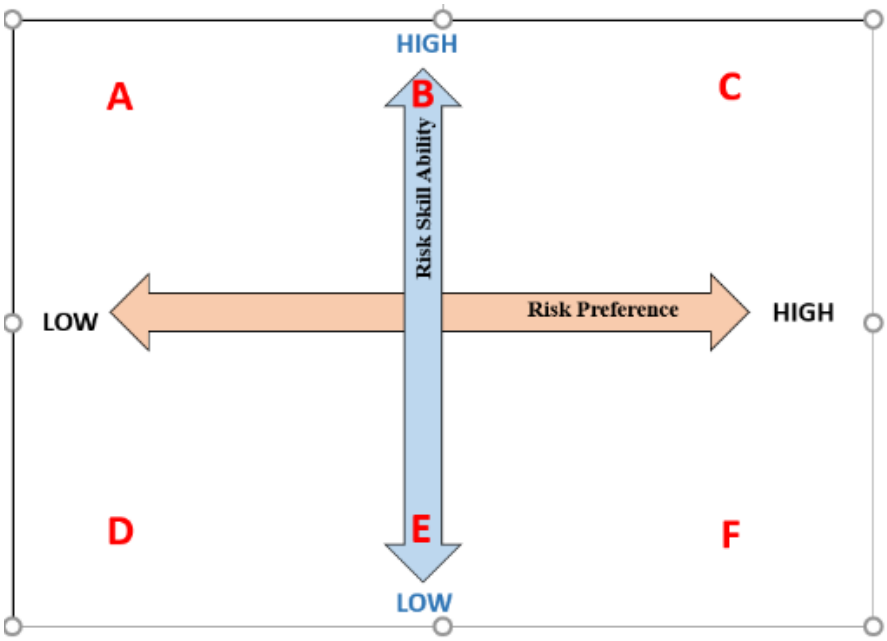
in the present study. The present cross-sectional study within an adolescent sample investigated three aims i) whether different psychopathy subdomains are associated with risk skill ii) whether associations with risk taking might depend on which psychopathy subdomains are elevated, and iii) whether risk skill acts as a moderator in the association between psychopathy subdomains and various aspects of risk taking. It may be, as outlined above, that the subdomains of psychopathy that are related to positive risk taking or better executive functioning are those that are associated with better risk skill. We will explore that possibility by including the three psychopathy subdomains of grandiose/manipulative traits (the interpersonal domain), callous/unemotional traits (the affective domain), and impulsive/irresponsible traits (the behavioural domain). For the second aim, we would expect that impulsivity would be associated with risk taking. This is based on prior research showing this consistent finding. Finally, we investigated whether risk skill was a moderator in the association between psychopathy and risk taking. We expected that those higher on psychopathy but with better risk skill might show lower risk taking. Again, we explored whether this might be relevant to one of the psychopathy subdomains.

We created a new task to further the aims of the present study. The Risk Skill task yielded both an index of risk skill ability as well as risk preference. High risk skill is when a person consistently and predictably selects certain risks over others, suggesting an intentional approach. Low risk skill is when risk choices are not consistent and predictable, suggesting that they have a strong element of randomness to them. People with a positive risk preference will choose an option with a higher possible reward and lower chance of reward, even if it has a lower average reward than the other option. People with zero risk preference just choose the highest average reward. People with a negative risk preference will choose an option with a lower possible reward and higher chance of reward, even if it has a lower average reward than the other option.

Figure 1 shows some examples of people at different points on these two dimensions. Individuals "A", "B" and "C" all represent high risk skill; however, the way these hypothetical people are making choices may be very different from each other.

Figure 1

A pictorial diagram depicting some of the different response styles on the risk skill task



Risk skill is only a measure of how consistently a strategy is adhered to rather than what likely method/strategy an individual is using to make selections. Individual "A" may be considered systematic but risk averse, having a strong negative risk preference, but a high-risk skill ability score. Individual "B" has no risk preference and a high skill score. They may be considered systematic and rational, selecting the choice with the highest chance of reward regardless of the potential reward value. Individual 'C' may be considered systematic risk preferring, having both a high-risk skill ability and strong positive risk preference. They may always select the option with the highest potential reward regardless of the average likelihood of winning. Individuals "D", "E" and "F" have no apparent systematic method for making choices across trials. Choices from one trial to another appear

random and chaotic; however, these individuals may still differ on their risk preference (value of high reward regardless of its likelihood).

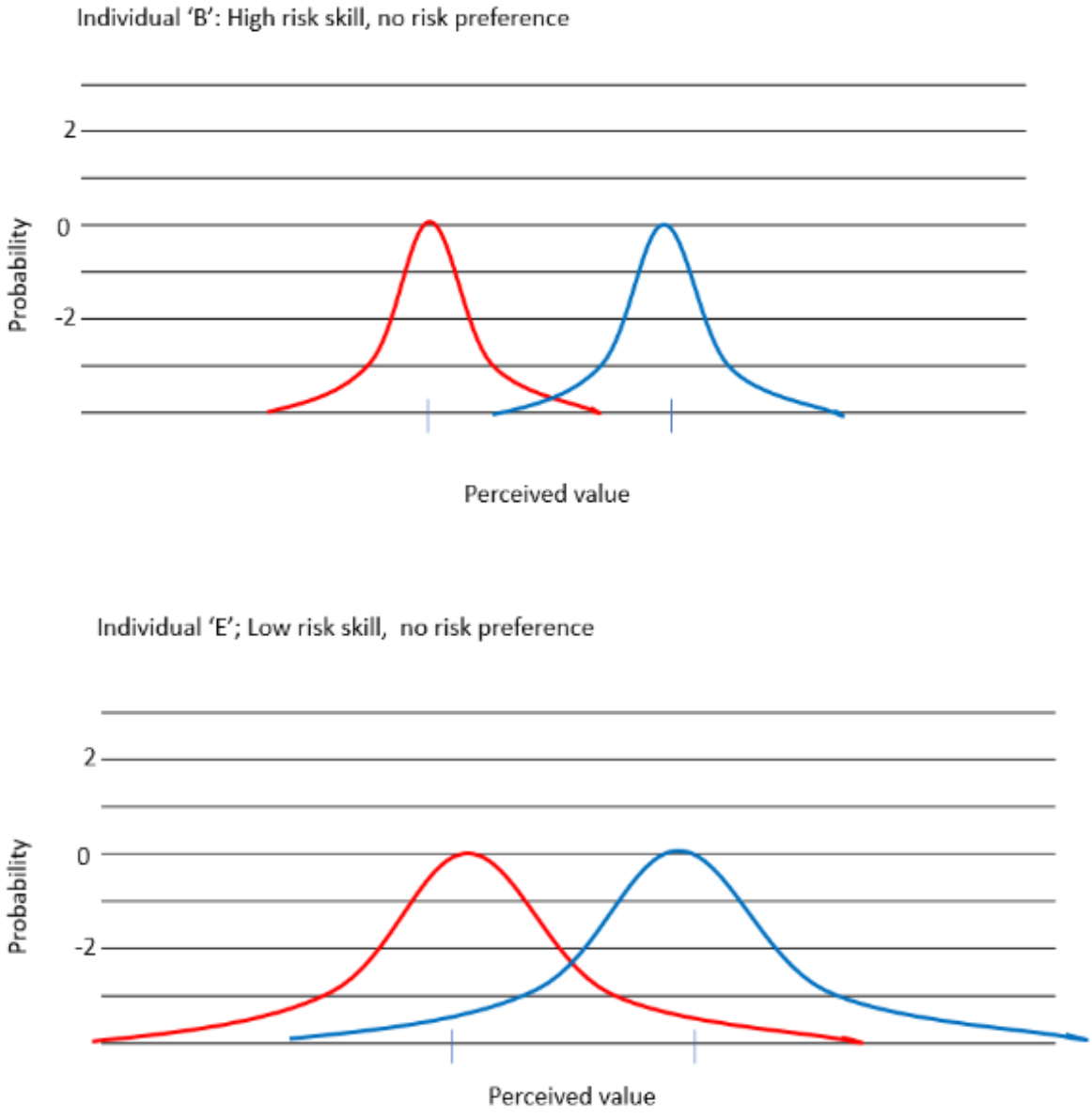
The risk skill task uses an underlying model as a scoring tool. In other words, there is a mathematical model that allows a complex set of sixty different choices to be summarized with two variables: risk preference and risk skill ability. This underlying model is adapted from signal detection theory (Peterson et al., 1954). This general framework provides a useful way to understand how people choose between two possible choices. Here, the choice is modelled as two random draws from two normal distributions. These distributions represent the perceived value of each possible choice. The participant is modelled as choosing the option that had the higher draw (higher perceived value). Normal distributions have a mean and a standard deviation. The mean of each normal distribution is its average perceived value. This is determined by the nature of the choice and the participant's risk preference (e.g. a high-risk high-reward option will have a high average perceived value to a participant with a strong positive risk preference). The standard deviation of the two normal distributions is equal. The standard deviation is the measure of risk skill: a lower standard deviation leads to more consistent choices. By fitting this model to each participant's data, each participant's dataset can be scored for further analysis.

To further aid understanding of how risk skill ability can vary within the risk skill task, Figure 2 depicts a diagrammatic representation of two hypothetical people. These individuals both show no risk preference, but they vary on levels of risk skill. The normal distributions (both red and blue) depict two different distributions of perceived value for two possible choices. Individual "B" has minimal variability in how choices are selected. This is modelled by a small standard deviation to the distributions; there is minimal overlap between the distributions. In contrast, Individual "E" has a high level of variability in how choices are selected, modelled by large standard deviations in the distributions. There is a large

amount of overlap between the distributions. This means that this participant will less consistently choose the option that has greater average perceived value to them.

Figure 2

Example normal distributions in the underlying model



We examined the three psychopathy subdomains (grandiose/manipulative, callous/unemotional and impulsive/irresponsible), self-reported rebellious risk taking, self-reported risk perception, number of crashes on a risk taking task, risk preference and risk skill ability within a sample of adolescents recruited from seven schools, colleges and sixth forms.

Given that psychopathy traits lie on a continuum and found to be present at varying degrees within community samples, we chose an adolescent community sample where psychopathy traits and engagement in risk taking is likely to be present along a broad spectrum to varying levels.

Method

Participants

In order to calculate the required sample size for the study, a power analysis was performed using G* Power 3.13. Calculations revealed that in order to yield a power of between 0.8 and 0.9 with six individuals predictors (Gender, IQ, risk skill, callous/unemotional, grandiose/manipulative and impulsive/irresponsible) and three interaction predictors, would need a sample size of between 160-210 individuals. Overall, 313 adolescents ages 16-19 years (M = 16.70, SD = 0.70;) were recruited from seven schools, colleges and sixth forms across the North West England in 2019/2020. Most participants were female (N = 216) and white British (94.89%). The majority reported their parents owned their own home (81.7%) and had roughly the same amount of money in comparison to peers (60.10% similar, 16.6% less money, 15.7% more money). Regarding parental education, most parents obtained some level of qualification (mother, 31.6%; father, 31.31%) or secondary education to A-level standard (mother = 24.3%, father = 17.25%). A similar proportion were educated to degree (BSc) or above (mother, 25.60%; father 21.73%). A small number of parents had not obtained any level of qualification (mother, 3.2%; father, 5.43%). Participant GCSE mathematics scores ranged from level 3 to 9 (M = 5.71, SD = 1.17) and GCSE English Language ranged from level 3 to 9 (M = 6.20, SD = 1.32).

Procedure

Head teachers or psychology teachers from schools, colleges and sixth forms from a range of social economic catchment areas and Ofsted ratings were approached via email or telephone communication and invited to take part in the study. In total, seven schools or colleges were recruited. Each school varied on recruitment success rate (6.7%, 29.7%, 10.2%, 29.4%, 29.4%, 12.5%, 6.1%, 12.1%). Meetings were set up with teachers interested in the project to discuss feasibility of how the study may effectively be run at each school, college and sixth form. All materials and tasks were shared and discussed with teachers prior to recruitment. Teachers disseminated information to students at their site and students that were interested were recorded. Specific times and dates for the study were prearranged with schools, colleges and sixth forms and students that expressed an interest in taking part in the study were given a brief talk about the nature of the research from the researcher where they could ask questions and find out more information. Heads of schools acted in loco parentis, and participants themselves provided written consent (countersigned by the researcher) to take part in the project (see Appendix B). Legally, in the UK, young people aged 16 years and over can give informed consent. Data collection took part in a quiet room in a single time block within the school or college in small groups and with a teacher present.

Computerised tasks were completed on laptops and we provided headphones. First, participants generated a seven-digit unique ID code and recorded this on the outside of an envelope. The demographics questionnaire was completed first, with the two computerised tasks and three self-report questionnaires completed in a pseudo random order. To maintain confidentiality, participants sealed their own envelopes containing their completed self-report questionnaires and this was not seen by teachers. Envelopes were collected by the researcher.

Participants were compensated with an entry into a £30 prize draw. Each participant obtained at least one prize draw entry, however, depending on performance in the computer tasks up to three entries could be obtained. This was to maintain participants' motivation and interest throughout the study. Based on feedback from teachers, participants entered the prize draw for their school, college or sixth form rather than entry into an overall prize draw. As the distribution of participants recruited from each school, college and sixth form varied significantly (19 versus 92 participants; $M = 44.7$), the number of £30 vouchers available (one to three vouchers) was relative to the number of students recruited from that particular site. An informal presentation was offered by the researchers to each school, college or sixth form and teachers were informed which student won the prize draw and distributed the vouchers accordingly. University of Liverpool gave ethical approval for the project "Decision making and risk taking in adolescents." Reference 4609 (see Appendix A).

Measures

Psychopathy

The Youth Psychopathic Traits Inventory (YPI; Andershed et al., 2002) is a 50-item self-report tool measuring psychopathic personality traits in community samples of adolescents (12 years and above). Individuals respond to each item on an ordinal 4-point Likert response scale ranging from "*does not apply at all*" (1) to "*applies very well*" (4). The YPI is based on Cooke and Michie's (2001) three-factor psychopathy construct namely the interpersonal, affective, and behavioural domains. There are 10 subscales (each consisting of five items), organised by domain. Within the interpersonal domain (labelled Grandiose/Manipulation) subscales included are designed to measure dishonest charm, grandiosity, lying and manipulation. In the Affective domain (labelled

Callous/Unemotional), subscales included measure callousness, unemotionality and remorselessness. The behavioural domain (labelled Impulsive/Irresponsible) includes subscales designed to assess impulsiveness, thrill seeking and irresponsibility (Andershed et al., 2002). Items are not framed as deficits reducing the likelihood of under reporting (Skeem & Cauffman, 2003). Higher scores reflect an increased presence of psychopathic traits. The internal consistency (based on Cronbach's alpha; Cronbach, 1951) for the psychopathy dimensions has previously been reported as .84 for Grandiose/Manipulative, .74 for Callous/Unemotional, .78 for Impulsive/Irresponsible, and .88 for the YPI total (Andershed et al., 2002). In the present study, similar α coefficients were found and are outlined in Table 1.

Self-reported risk taking & risk perception

The Adolescent Risk-Taking Questionnaire (ARQ; Gullone et al., 2000) is a self-report measure of risk-taking propensity for adolescents aged 11- 18 years. It consists of two scales of risk-taking: behaviour and risk judgement (perception of risk) across 22 items. The risk-taking behaviour component asks adolescents to rate the degree to which they have participated in different types of risks using a 5-point Likert scale ranging from '*never done'* (0) to '*done very often'* (4). Subscales of risk include; thrill-seeking (seven items, e.g. going parachuting), Rebelliousness (five items, e.g., staying out late), Reckless (five items, e.g., stealing cars and going for joy rides) and antisocial behaviour (five items, e.g. cheating on an exam). Higher scores indicate greater levels of risk-taking behaviour. Cronbach's alpha for this sample ranged from 0.20 to 0.81, with poor internal consistency for items relating to thrill-seeking, recklessness and antisocial behaviour (see Table 1). Rebelliousness yielded good internal consistency (.81).

The risk-taking judgement (perception scale) asks adolescents to rate how risky they think each of the 22 activities or behaviours are using a 5-point Likert scale from '*not risky at all' (0) to 'extremely risky' (4).* Higher scores indicate higher perceptions of risk. For this sample, only the rebellious (α=.666) and reckless subscale (α= .665) yielded acceptable reliability. For consistency, only the rebellious behaviour subscale and rebellious risk judgement were utilised for further analysis. Table 1 reports alpha coefficients for thrill-seeking and antisocial judgements. The ARQ has strong construct validity and good convergent and discriminant validity. It also has good internal consistency and moderate test-retest reliability (Gullone et al., 2000a; Gullone et al., 2000b).

Risk taking task

'Stoplight' (Chein et al., 2011; Steinberg et al., 2008) is a well-validated paradigm measuring laboratory-based risk-taking behaviours. Participants complete one trial of the stoplight task which includes crossing twenty junctions. It is a first-person computerised driving simulation task where participants "drive" down a straight road across twenty intersections from the vantage point of the driver. The goal is to reach "a party" in under five minutes. A countdown clock is visible along with the number of junctions remaining. As the vehicle approaches each intersection, a traffic signal turns yellow (at slightly variable timings) and participants decide whether to stop the car by pressing the "space bar" on the keyboard. The speed of the vehicle is constant and cannot be changed and participants can only brake once the light has turned yellow.

Participants were told that depending on their decision, one of three outcomes could occur. A screen shot of the task instructions given to participants is provided in Appendix C. Full participant instructions are If participants brake before the light turned red at the

intersection, the car stops safely, but a 3-second time delay would be incurred. If participants do not apply the brake and pass through the intersection without crashing, no time is lost. However, if they do not apply the brake or brake too late and the car crashes, a 6-seconds time delay would occur (double the delay than if they had chosen to stop the car). Participants are unable to see an approaching car at each intersection, therefore, do not know which intersections are safe and which will result in a crash (squealing tires, a bang and smashed windscreen). Thus, running the light is the riskier option because it could result in a crash but could also help get to the destination more quickly. To reach the destination before the time runs out, participants will have to take some risks. The probability of crashing at an intersection and the distance in between intersections is varied. High risk taking is indicated by the total number of crashes. Participants were informed that if they get to the party before the time runs out, they get an additional entry into the £30 prize draw.

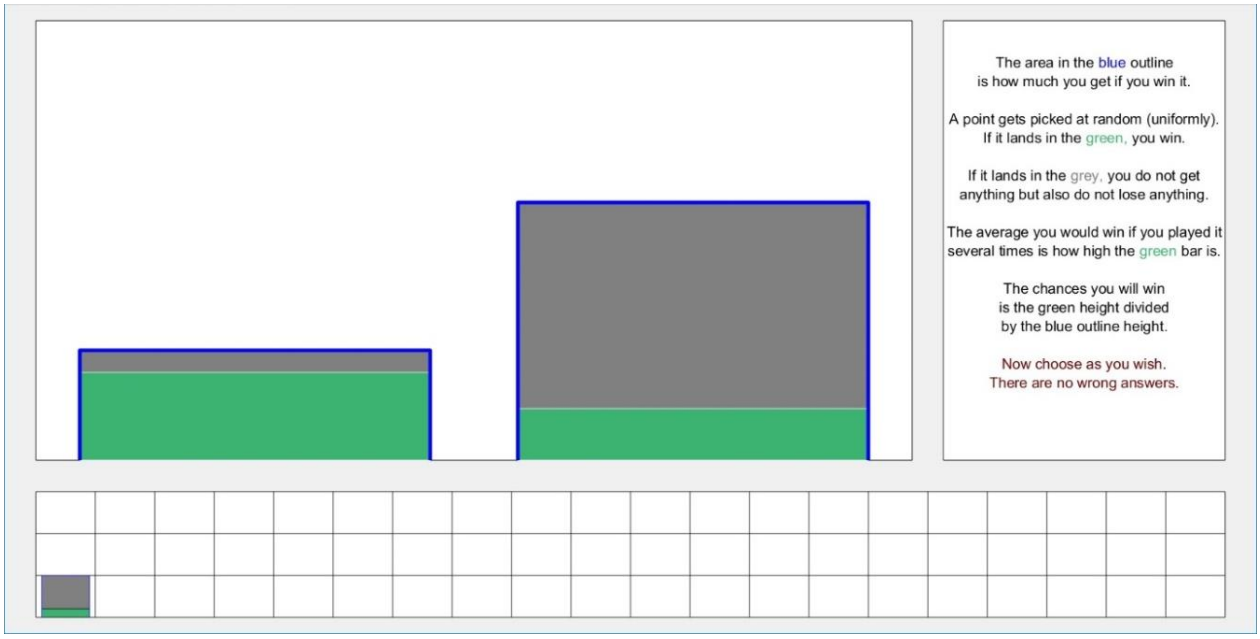
The stoplight task has been shown to be significantly related to real world risk taking (health risks) among adolescents and adults (Kim-Spoon et al., 2016). In relation to psychopathy, risk taking (measured by the stoplight task) was not associated with callous/unemotional traits in adolescents (Centifanti & Negen, 2018). Also, adolescents with high callous/unemotional traits without conduct disorder showed less risk taking on the stoplight task compared to adolescents with both high callous/unemotional traits and conduct disorder (Fanti et al., 2016). To ensure that driving experience did not affect task performance, individuals were asked if they were currently driving (licensed) or enrolled in driving lessons.

Risk Skill Task

The task requires participants to make responses using the track pad/mouse. Before the task begins, instructions are displayed on the screen and small checks are made to ensure that individuals understand the task. There are 60 trials in total where individuals are presented with two bars of differing heights and proportions of green shading within the bar (see Figure 3). The 60 bar choices are recorded at the bottom of the screen with the current trial in the main window. Figure 3 represents trial two of the 60 trials with the first-choice selection made by the individual (trial one) recorded in the 'holding area' log at the bottom. For each bar, the height (blue outline) represents the potential reward value. The higher the bar, the greater the potential reward obtained. The green shaded area within each bar represents both the average reward that would be gained if the game were played several times and the probability of winning on that trial. The aim of the task is to obtain as many points as possible. Importantly, feedback is not provided; the task is not intended to measure how people respond to feedback, but rather how consistently they make decisions about risks in a static environment. Participants were informed that the person scoring the highest number of points within that session would receive an additional entry into the £30 prize draw.

Figure 3

An example of the risk skill task showing a screen shot of the second trial of 60



Risk skill ability. This lies on a continuum and is measured as a standard deviation. The underlying decision is modelled as a draw from two normal distributions, one for each choice, with the higher draw being selected (borrowing heavily from signal detection theory; see Figure 2). A low standard deviation indicates a high-risk skill ability since it means that choices tend to be consistent and predictable based on the choices offered. A high standard deviation indicates a low-risk skill ability since choices are highly variable, inconsistent and appear random.

Risk preference. This is an index of how much average reward a person is willing to give up in order to get a more preferable risk and also whether they prefer a low-risk low-reward option or a high-risk high-reward option. An individual that has a low risk preference

underestimates their chances of receiving the reward on the higher risk option, leading them to prefer low-risk, low-reward options. In Figure 3, people with low risk preference would favour the bar on the left. Choosing this bar is a lower-risk lower-reward option; the green area takes up more of the blue outline, but the blue outline is smaller. If a participant has a strong risk preference, they would be willing to give up the higher average reward (height of the green bar) in exchange for the chance to win the larger possible reward on the chance that they may "win big", favouring the bar on the right. People who do not appear to show any risk preference will not favour the bar on the left (lower risk, lower reward) nor the bar on the right (high risk, higher reward). They will have a risk preference score that is close to zero. High risk preference is indicated by higher positive values, whereas low risk preference is indicated by higher negative values.

Data Analysis Plan

The data were analysed using Jamovi 1.1 (2019), which has a core of R language (R Core Team, 2018). The study had three aims i) whether different psychopathy subdomains are associated with risk skill ability, ii) whether associations with risk taking might depend on which psychopathy subdomains are elevated, and iii) whether risk skill ability acts as a moderator in the association between psychopathy subdomains and various aspects of risk taking. To test these, correlations were run first and relations between psychopathic subdomains (callous/unemotional, grandiose/manipulative, and impulsive/irresponsible), number of crashes (from the driving task) and rebellious risk taking (from the ARQ), rebellious risk perception (from the ARQ), risk preference (from the risk skill task) and risk skill ability (from the risk skill task) were examined. In addition, other possible covariates

and demographic variables such as age were explored to identify important variables that may need to be controlled for within the analysis. Driving experience was not included in the correlations, therefore an independent t-tests was conducted.

To address our aims, a series of hierarchical multiple regressions were conducted. To assess whether specific psychopathy subdomains were associated with risk skill ability, we performed a hierarchical regression with two steps whilst controlling for covariates: age, GCSE maths and gender (male =1, other=0). Step 1 regressed risk skill ability against age, GCSE maths and gender while step 2 regressed risk skill ability on psychopathy subdomains. To explore the other aims, four further hierarchical regressions were conducted. The second hierarchical regression explored the association between psychopathy subdomains and number of crashes (step 1 and step 2) to address part of aim ii. A third step was included to address part of aim iii, whether risk skill ability moderated this association between psychopathy subdomains and crashes. As before, step 1 included the covariates age, GCSE maths and gender (male=1, other=0) in addition to risk skill ability since this was to be our moderator in step 3. Step 2 regressed crashes on psychopathy subdomains. We compared the change in variance from step 1 to step 2 to assess how much variance was explained by psychopathy subdomains alone and hence to explore whether associations with crashes were dependent on which psychopathy subdomains was elevated. Step 3 included three multiplicative interaction terms of callous/unemotional*risk skill, grandiose/manipulative*risk skill, and impulsive/irresponsible*risk skill to assess whether risk skill ability moderated the association between crashes and psychopathy subdomains. We examined whether the increase in variance explained from step 2 to step 3 was significant to see if we should run post-hoc tests of where the moderation lay.

To address the remaining aspects of aim ii and aim iii, three hierarchical regression were performed in the same way to the description above. However, instead of crashes being

regressed, we examined rebellious risk taking (from the ARQ), rebellious risk perception (from the ARQ) and risk preference (from the risk skill task). All multiple regressions were planned prior to data collection and there were no ad-hoc multiple regressions conducted. Therefore, the study did not require any manipulation of statistical significance testing.

Results

All participants data was included in the analyses. Outliers were not excluded due to the high sample size (313 participants). Overall, only 4% of the total data points were missing. A multiple computation was not completed given the large sample size and percentage of missing data was small (see Appendix F for a full breakdown of the missing data). In data sets where the missing data is less than 5%, consequences such as loss of power or biases are likely to be negligible (Graham, 2009). Table 1 presents descriptive statistics for the primary measures. Examination of skewness, kurtosis, violin and box blots showed that the data were within normal limits, with no outliers. Appendix D and E show that the means and standard deviations for the Adolescent risk taking questionnaire (ARQ) and Youth psychopathic trait inventory (YPI) are similar to those found in previous community adolescent samples. The ARQ mean item score for the rebellious behaviours subscale (range 0-4) in our study sample compared to a community sample with similar aged adolescents (Gullone et al., 2000) was 1.9 verses 1.6. On the rebellious perceptions subscale, the mean item score from our data was 1.76 compared to 2.35 in Gullone et al. (2000). A comparison of the mean and standard deviation item scores for the rebellious behaviours and rebellious perception subscales as a function of gender is included in Appendix D. The YPI was compared to two different studies (Andershed et al., 2007, Somma et al., 2018) which both used adolescent samples. Appendix E shows the mean and standard deviation item

scores for the YPI total and grandiose-manipulative, callous-unemotional and impulsive-irresponsible subscales as a function of gender. Our data was similar to both Andershed et al. (2007) and Somma et al. (2018), for example the mean item score for the YPI total for adolescent boys was 2.23 in our sample versus 2.39 in Andershed et al. (2007) and 1.88 in Somma et al. (2018). For girls, the mean item score for the YPI total was 1.96 in our sample compared to 2.29 in Andershed et al. (2007) and 1.65 in Somma et al. 2018. All standard deviations for the total scores for boys and girls in all three samples were approximately 0.4.

Inter-correlations of study variables

Table 2 presents the means, standard deviations and bivariate correlations of study variables. Firstly, associations among the dependent variables were explored, then, association were investigated in relation to psychopathy. Number of crashes and rebellious risk taking were positively correlated (r = .116, p = .046). Adolescents that had more crashes on the driving task and reported elevated levels of rebellious risk taking were associated with higher risk preferences (on the risk skill task) and as perceiving rebellious risks to be less risky.

Regarding the associations between dependent variables and psychopathy, significant negative associations were found between rebellious risk perception and all the psychopathy subdomains (*rs* ranged from -.229 to -.408, p = <.001) meaning adolescents with elevated levels of any of the three psychopathy subdomains, they were more likely to perceive rebellious risks as less risky. Regarding risk taking, elevated impulsive/irresponsible traits were positively associated with more crashes and higher levels of rebellious risk taking (*rs* ranged from .18 to .61, p values ranged from .002 to <.001). Similarly, elevated grandiose/manipulative traits were also associated with higher levels of rebellious risk taking (r = .312, p < .001). In relation to rebellious risk preference, all psychopathy subdomains

were negatively associated. This means that adolescents with elevated scores on grandiose/manipulative, callous/unemotional or impulsive/irresponsible are more likely to perceive rebellious risk behaviours as less risky (*rs* ranged from .184 to .244, *p* values ranged from .002 to <.001). Adolescents with elevated grandiose/manipulative traits (compared to the other subdomains) are the most likely to perceive rebellious risk behaviours as less risky.

Risk skill ability was negatively associated with grandiose/manipulative traits (r = -.15, p = .011). This indicated that adolescents with elevated grandiose/manipulative traits had higher risk skill abilities on the risk skill task (indexed by a smaller standard deviation) Although risk skill did not show a significant association with crashes nor rebellious risk taking, it was negatively associated with risk preference (from the risk skill task). Given smaller risk skill scores indicate a higher levels of risk skill, adolescents with better risk skill abilities were more likely to have higher risk preferences on the risk skill task.

We also examined associations with potential covariates. Higher rebellious risk taking was associated with being older in age (r = .152, p = .008)) and obtaining lower GCSE maths scores (r = -.158, p = .006). Crashes and family financial wealth (relative to peers) (r = .177, p = .003) were positively correlated, such that wealthier adolescents had a greater number of crashes. Adolescent young men showed lower rebellious risk preferences. Risk skill was negatively associated with GCSE maths scores indicating that higher risk skill abilities (smaller standard deviation scores) were associated with higher GCSE maths scores. Gender was negatively associated with rebellious risk taking and positively associated with risk preference. This indicates that adolescent men reported taking less rebellious risks than adolescent women/ other gender but had higher risk preferences on the risk skill task than women/other gender. Taken together, age, gender and GCSE maths scores show associations with risk skill ability, crashes, rebellious risk taking, risk preference and risk perception.

Thus, it will be important to include these variables as covariates in the hierarchical regressions.

T-tests were conducted to determine if driving experience was likely to be confounding the results. No significant differences between individuals with driving experience and those without were observed. Therefore, driving experience was not included as a covariate in the regressions.

Table 1

Descriptive and alpha coefficients for measures

Trait	Mean	SD	α	Skew	Std. error skewness	Kurtosis	Std. error kurtosis
Youth Psychopathic Inventory (YPI)							
Grandiose/Manipulative	37.9	10.3	0.908	0.35	0.14	-0.679	0.278
Callous/Unemotional	27	7.17	0.842	0.535	0.14	-0.415	0.279
Impulsive/Irresponsible	36.9	7.69	0.843	0.316	0.139	-0.081	0.278
Overall Psychopathy	102	20.5	0.928	0.166	0.142	-0.486	0.282
Adolescent risk taking questionnaire (ARQ)							
Thrill-seeking risk taking	5.94	2.6	0.198	0.587	0.14	0.419	0.279
Reckless risk taking	1.79	2.24	0.408	1.51	0.14	2.3	0.28
Rebellious risk taking	9.5	5.16	0.877	0.185	0.14	-0.876	0.279
Antisocial risk taking	7.87	2.66	0.58	0.453	0.14	0.591	0.28
Risk-taking behaviour total	25.1	9.47	0.807	0.504	0.141	-0.275	0.281
Thrill-seeking risk perception	8.7	3.1	0.589	0.33	0.139	0.351	0.276
Reckless risk perception	12.5	2.18	0.665	-0.638	0.138	0.051	0.276
Rebellious risk perception	8.81	2.8	0.666	0.315	0.138	0.233	0.276
Antisocial risk perception	8.55	2.85	0.599	0.239	0.138	0.238	0.276
Risk perception total	38.5	8.21	0.815	0.163	0.139	0.431	0.276
Risk skill Task							
Risk skill (consistency)	0.372	0.218		0.431	0.141	-0.57	0.281
Risk preference	-0.222	0.946		-0.119	0.141	1.32	0.281

Note. Risk Skill is measured as an SD. Greater risk skill is denoted by lower values, meaning they were more consistent in their choices.

Table 2

Zero-order correlations among main study variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. YPI GM	—											
2. YPI CU	0.553***	—										
3. YPI II	0.526***	0.327***	—									
4. crashes	0.072	0.018	0.18**	—								
5. Rebellious risk taking	0.312***	0.094	0.613***	0.116*	—							
6. Rebellious risk perception	-0.285***	-0.229***	-0.408***	-0.123*	-0.421***	—						
7. Risk Preference	0.244***	0.234***	0.184**	0.163**	0.177**	-0.196***	—					
8. Risk Skill	-0.15*	-0.085	-0.024	0.033	-0.059	0.106	-0.203***	—				
9. Age	-0.059	-0.165**	0.064	0.06	0.152**	0.036	-0.078	0.047	—			
10. Gender	0.251***	0.442***	0.018	-0.03	-0.177**	-0.018	0.143*	-0.097	-0.238***	—		
11. GCSE Maths	-0.043	-0.012	-0.12*	0.035	-0.158**	-0.091	-0.044	-0.123*	0.031	-0.042	—	
12. GCSE English	0.02	-0.14*	-0.131*	-0.015	-0.106	0.051	-0.045	-0.06	0.116*	-0.122*	0.384***	—
Mean	37.9	27	36.9	4.1	9.5	8.81	-0.222	0.372	16.7	0.304	5.71	6.2
SD	10.3	7.17	7.69	1.91	5.16	2.8	0.946	0.218	0.704	0.461	1.17	1.32

Note. YPI = Youth Psychopathic Traits Inventory; YPI_GM = Grandiose-Manipulative dimension; YPI_CU = Callous-Unemotional dimension; YPI_II = Impulsive-Irresponsible dimension ; risk preference and risk skill are taken from the Risk Skill task; rebellious risk taking and risk perception are taken from the ARQ. Gender ; males=1, females/other gender = 0. * $p < .05$, ** $p < .01$, *** $p < .001$

Which psychopathy subdomains relate to risk-skill?

We did not find compelling evidence that any subdomain was robustly associated with risk skill. Table 3 shows the results of the hierarchical regression with risk skill. Step 1 explained 2% of the variance of risk skill; however, this did not reach statistical significance. Nevertheless, GCSE maths was a significant unique predictor of risk skill in the negative direction (β=-.024, *p*=.039). As risk skill scores are standard deviations, lower risk skill indicates more consistency and hence higher risk skill abilities. Thus, higher GCSE maths scores are associated with higher risk skill. With the addition of the three psychopathy subdomains at step 2, the unique standardised beta for GCSE maths remained significant (β = -.023, p = .046) along with negative significant predictor effects for grandiose/manipulative traits (β = -.004, p = .011). Although step 2 reached statistical significance (R^2 = .048, p = .036), the incremental difference from step 1 to step 2 was not statistically significant, with only 2.5% of the variance in risk-skill explained when including psychopathy. Thus, psychopathy only explains a trivial amount of variance that was nonsignificant. Step 3 of the regression investigated part of our third aim (the moderating effect of risk skill ability) therefore will be discussed in a later section.

Table 3

Hierarchical Regression for risk skill task (consistency in choices)

	Task Based: Risk Skill Ability			
Step 1	**Uns beta**	**95% CI**	**SE**	**R^2**
Intercept	0.338	-0.313, 0.988	0.331	0.023
Age	0.011	-0.027, 0.049	0.019	
Gender	-0.037	-0.095, 0.021	0.030	
GCSE Maths	-0.024*	-0.046, -0.001	0.011	
Step 2				0.048 *
Intercept	0.412	-0.251, 1.074	0.336	
Age	0.010	-0.028, 0.048	0.019	
Gender	-0.016	-0.080, 0.049	0.033	
GCSE Maths	-0.023*	-0.045, -4.13e-4	0.011	
YPI GM	-0.004*	-0.008, -0.001	0.002	
YPI CU	0.001	-0.004, 0.006	0.002	
YPI II	0.002	-0.002, 0.006	0.002	
R^2 change to Step 2		0.025		

Note. YPI = Youth Psychopathic Traits Inventory; YPI_GM = Grandiose-Manipulative dimension; YPI_CU = Callous-Unemotional dimension; YPI_II = Impulsive-Irresponsible dimension. Gender ; 1 = male, 0 = female/other gender. * $p < .05$, ** $p < .01$, *** $p < .001$; step 1 F (3, 277) = 2.13; step 2 F (6, 274) = 2.28; step 2-step 1 F(3, 274) = 2.41.

Which psychopathy subdomains relate to risk taking?

Table 4 presents two hierarchical regressions, the first for crashes and the second for rebellious risk taking. For number of crashes, step 1 explained a negligible amount of the variance, with only 0.4% accounted for. Step 1 was not significant, and no predictors showed unique main effects. Adding in the three psychopathy subdomains in step 2 increased the overall variance explained; however, step 2 variance remained non-significant (R^2 = .045 p = .079). The incremental change from step 1 to step 2 was significant, accounting for 4.1% of the variance, with impulsive/irresponsible traits showing unique predictor effects (β = .051, p = .005).

The second regression assessed the association between rebellious risk taking with the three psychopathy subdomains, showing impulsive/irresponsible traits to be a significant predictor. Exploring each step of this regression, step 1 explained 7.4% of the variance in rebellious risk taking. Both gender (β = -1.650, p = .015) and GCSE maths (β = -.771, p = .003) were significant unique predictors in the negative direction. This indicated that adolescents with higher self-reported rebellious risk taking were more likely to have lower GCSE maths scores. It also showed that adolescent women/other gender were more likely to have higher rebellious risk taking than adolescent men in our sample. Adding the three psychopathy subdomains to step 2, led to an incremental difference of 36.1% in variance explained. As observed with crashes, impulsive/irresponsible traits were a significant unique predictor of rebellious risk taking (β = .405, p = <.001). Gender remained a significant predictor in the negative direction (β = -1.718, p = .004). As mentioned above, step 3 of the regression investigates part of the third aim and will therefore be discussed in a later section.

Taken together, higher levels of impulsive/irresponsible traits predicted higher number of crashes in the driving task and higher rebellious risk taking as measured by the ARQ.

Which psychopathy subdomains relate to rebellious risk perception on the ARQ and risk preference choices on the Risk Skill task?

Table 5 shows the results of the hierarchical regression with rebellious risk perception and risk preference. For rebellious risk perception, step 1 revealed a non-significant variance of 2.5%, with no significant predictors. However, the addition of the three psychopathy measures in step 2, showed a sizeable incremental change from step 1 to step 2, explaining 18% of the variance in rebellious risk perceptions. Impulsive/irresponsible traits were a significant unique predictor of rebellious risk perception in the negative direction (β = -.135, p = <.001). Hence, adolescents with elevated impulsive/irresponsible traits perceived rebellious risk taking as less risky than adolescents with lower impulsive/irresponsible traits. GCSE maths was also a unique negative predictor for rebellious risk perception (β = -.368, p = .006) indicating adolescents with high GCSE maths scores perceived rebellious risks as less risky than adolescents with lower GCSE maths scores. Thus, in relation to rebellious risk perception (from the ARQ), impulsive/irresponsible traits were the only psychopathy subdomain that showed an association.

Regarding risk preference (from the risk skill task), step 1 explained 7.1% of the variance. Risk skill ability was a significant unique predictor in the negative direction (β=-.887, p=<.001) and gender a significant predictor in the positive direction (β=.281, p=.027). Again, as risk skill ability scores are standard deviations, lower scores indicate higher risk skill abilities. Therefore, adolescents that were more consistent in their choices (indexed by

higher risk skill ability) also preferred riskier options than adolescents that were inconsistent in their choices. Similarly, adolescent men were associated with having riskier preferences on the risk skill task compared to adolescent women/other gender. Including the three psychopathy measures in step 2 explained a statistically significant proportion of the variance (R^2= .117 p= <.001). There was also a significant incremental change of 4.6% in the variance accounted for in risk preference from step 1 to step 2. GCSE maths was no longer a significant unique predictor; however, risk skill ability remained a significant negative predictor (β=-.800, p=.002).

Taken together, adolescents with elevated impulsive/irresponsible traits were associated with more crashes, higher self-reported rebellious risk taking and lower rebellious risk perceptions.

Table 4

Hierarchical Regressions for the two indices of risk taking.

	Risk Task: Crashes				Self-Report: Rebellious Risk Taking			
Step 1	**Uns beta**	**95% CI**	**SE**	**R^2**	**Uns beta**	**95% CI**	**SE**	**R^2**
Intercept	2.623	-3.127, 8.373	2.921	0.004	0.969	-13.985, 15.924	7.596	0.074***
Age	0.076	-0.260, 0.411	0.170		0.855	-0.016, 1.727	0.443	
Gender	-0.151	-0.664, 0.363	0.261		-1.650*	-2.984, -0.316	0.677	
GCSE Maths	0.017	-0.181, 0.216	0.101		-0.771**	-1.286, -0.257	0.261	
Risk skill ability	0.351	-0.692, 1.394	0.530		-2.711	-5.425, 0.003	1.379	
Step 2				0.045				0.435***
Intercept	1.340	-4.474, 7.155	2.953		-10.299	-22.363, 1.765	6.128	
Age	0.028	-0.305, 0.361	0.169		0.514	-0.175, 1.204	0.350	
Gender	-0.152	-0.718, 0.414	0.287		-1.718**	-2.891, -0.545	0.596	
GCSE Maths	0.062	-0.136, 0.259	0.100		-0.409	-0.817, -4.53e-4	0.207	
Risk skill ability	0.409	-0.632, 1.450	0.529		-2.085	-4.244, 0.074	1.097	
YPI GM	0.003	-0.027, 0.033	0.015		0.031	-0.030, 0.093	0.031	
YPI_CU	-0.008	-0.049, 0.033	0.021		-0.054	-0.138, 0.030	0.043	
YPI II	0.051**	0.016, 0.087	0.018		0.405***	0.331, 0.479	0.038	
Step 3				0.054				0.440***
YPI_GM ✻ risk skill ability	-0.109	-0.249, 0.032	0.072		0.015	-0.277, 0.307	0.148	
YPI CU ✻ risk skill ability	0.072	-0.106, 0.250	0.090		-0.216	-0.583, 0.151	0.187	
YPI II ✻ risk skill ability	0.074	-0.086, 0.234	0.081		-0.085	-0.419, 0.249	0.170	
R^2 change; Step 1 to Step 2		0.041*				0.361***		
R^2 change; Step 2 to Step 3		0.008				0.005		

Note. YPI = Youth Psychopathic Traits Inventory; YPI_GM = Grandiose-Manipulative dimension; YPI_CU = Callous-Unemotional dimension; YPI_II = Impulsive-Irresponsible dimension. Gender; 1= male, 0=female/other gender. ** $p < .05$, ** $p < .01$, *** $p < .001$.* Crashes; step 1 $F(4, 276) = 0.309$; step 2 $F(7, 273) = 1.845$, step 3 $F(10, 270) = 1.530$. Rebellious Risk Taking; step 1 $F(4, 275) = 5.51$; step 2 $F(7, 272)=29.89$; step 3 $F(10, 269)=21.14$

Table 5

Hierarchical Regression for rebellious risk perception and risk preference.

	Self-report: Rebellious Risk Perception				Task based: Risk Preference			
Step 1	**Uns beta**	**95% CI**	**SE**	**R²**	**Uns beta**	**95% CI**	**SE**	**R²**
Intercept	6.870	-1.485, 15.224	4.244	0.025	1.450	-1.327, 4.227	1.411	0.071***
Age	0.171	-0.317, 0.659	0.248		-0.066	-0.228, 0.096	0.082	
Gender	0.028	-0.712, 0.767	0.375		0.281*	0.032, 0.529	0.126	
GCSE Maths	-0.245	-0.530, 0.041	0.145		-0.055	-0.151, 0.041	0.049	
Risk skill ability	1.279	-0.232, 2.791	0.768		-0.887***	-1.391, -0.383	0.256	
Step 2				0.205***				0.117***
Intercept	12.252**	4.481, 20.023	3.947		0.300	-2.495, 3.096	1.420	
Age	0.268	-0.178, 0.715	0.227		-0.066	-0.226, 0.094	0.081	
gender	0.406	-0.345, 1.157	0.382		0.124	-0.148, 0.396	0.138	
GCSE Maths	-0.368**	-0.630, -0.106	0.133		-0.043	-0.138, 0.052	0.048	
Risk skill ability	1.021	-0.368, 2.411	0.706		-0.800**	-1.301, -0.300	0.254	
YPI GM	-0.009	-0.049, 0.031	0.020		0.009	-0.006, 0.023	0.007	
YPI_CU	-0.037	-0.091, 0.017	0.027		0.014	-0.005, 0.034	0.010	
YPI II	-0.135***	-0.182, -0.087	0.024		0.011	-0.007, 0.028	0.009	
Step 3				0.215***				0.120***
YPI GM ✻ risk skill ability	-0.138	-0.326, 0.049	0.095		-0.026	-0.094, 0.042	0.035	
YPI CU ✻ risk skill ability	0.144	-0.091, 0.379	0.119		0.020	-0.066, 0.106	0.044	
YPI II ✻ risk skill ability	0.139	-0.075, 0.353	0.109		0.028	-0.049, 0.105	0.039	
R² change; Step 1 to Step 2		0.180***				0.046**		
R² change; Step 2 to Step 3		0.010				0.003		

Note. YPI = Youth Psychopathic Traits Inventory; YPI_GM = Grandiose-Manipulative dimension; YPI_CU = Callous-Unemotional dimension; YPI_II = Impulsive-Irresponsible dimension. Gender ; 1= male, 0=female/ other gender ** p < .05, ** p < .01, *** p < .001.* Rebellious Risk Perception; step 1 $F(4, 273) = 1.73$; step 2 $F(7, 270) = 9.95$; step 3 $F(10, 267) = 7.3$. Risk preference; step 1 $F(4, 276) = 5.29$; step 2 $F(7, 273) = 5.17$; step 3 $F(10, 270) = 3.67$

Does risk skill affect how people with higher psychopathy traits take or perceive risks?

The results did not show risk skill ability to be a moderator in the association between psychopathy subdomains and various aspects of risk taking. Adolescents with elevated psychopathic traits and that also had higher risk skill abilities did not have fewer crashes nor less rebellious risk taking than adolescents with elevated psychopathic traits but lower risk skill ability (Table 4, step 3). The incremental variance explained by adding the interaction of risk skill to each psychopathy subdomain did not reach statistical significance for crashes (ΔR^2 from step 2 to step 3 = .008, p = .493) nor rebellious risk taking behaviour (ΔR^2 from step 2 to step 3 = .005, p = .474).

Similarly, the results also showed no difference between adolescents with elevated psychopathic traits with high risk skill abilities compared to adolescents with elevated psychopathic traits and lower risk skill abilities in their perception of rebellious risks (rebellious risk perception) nor risk preference on the risk skill task (Table 5, step 3). No unique interaction predictors were found and the incremental variance accounted for with the addition of interaction variables did not yield significant results for risk perception (ΔR^2 from step 2 to step 3=.010, p = .353) nor risk preference (ΔR^2 from step 2 to step 3= .003, p = .848).

In summary, higher risk skill abilities do not appear to affect how people with higher psychopathy traits take, perceive, or prefer risks.

Discussion

To our knowledge, the present study is the first to examine the concept of risk skill ability (the consistent use of a strategy) as a potential underlying mechanism in the association between psychopathy and risk taking. Using a novel risk task in a large adolescent community sample, three specific aims were explored. Firstly, we examined whether unique contributions of psychopathy subdomains traits were associated with risk skill ability. Secondly, we examined the relationship between individual psychopathy subdomains with two indices of risk taking, rebellious risk perception and risk preference. Thirdly, we explored whether risk skill ability would moderate the relationships between psychopathy and risk taking, rebellious risk perception and risk preference. The analysis revealed several main findings which will be addressed in turn.

Is risk skill ability associated with psychopathy?

Contrary to expectations, risk skill ability was not associated with psychopathy. However, there was a significant yet weak association between risk skill ability and grandiose/manipulative traits. It may be that the ability to lie, deceive and manipulate others for personal gain in a convincing way (characterised by high grandiose/manipulative traits) requires similar abilities associated with consistent, organised, and strategic responding. In an adolescent study investigating the relationship between psychopathy and physiological responses to a signalled and un-signalled startle stimulus, MacDougall et al (2019) found associations between grandiose/manipulative traits, (particularly planning, manipulation, and charm), skin conductance and goal-directed attention. They suggest that adolescents with higher grandiose/manipulative traits may be more cognitively activated manifesting in a heightened awareness and orientation to cues in their environment, thus helping them be

more prepared for stimuli that is unpredictable and unpleasant. This may make them more effective at engaging in strategic, consistent, and well-planned responses because they are more prepared for the worst.

Similarly, there may be other aspects of this subdomain that hold more of an adaptive function. Grandiosity and an inflated sense of self-importance may result in psychological resilience, robustness, and a prioritisation of personal wellbeing. This may be protective against criticism, high stress, or attacks to self-confidence, allowing a person to exert their own dominance, views and needs in a relatively fearless manner. Similar adaptive traits such as fearlessness, dominance, emotional stability and venturesomeness (Drislane et al., 2014) characterise the interpersonal subdomain "boldness" in the adult psychopathy literature. This trait has been associated with three of the four grandiose/manipulative YPI subscales. In comparison, only one callous/unemotional subscale (unemotionality) and one impulsive/irresponsible subscale (thrill-seeking) were related to "boldness" (Drislane et al., 2014). Given that some aspects of psychopathy have been linked to more positive risk taking, using a measure that incorporates adaptive manifestations of psychopathy may yield important associations with risk skill.

Are unique psychopathy subdomains differentially associated with number of crashes, rebellious risk taking, rebellious risk perception and risk preference?

Impulsive/irresponsible traits were uniquely related to risk-taking behaviour across various measures used in the present study (crashes rebellious risk taking and rebellious risk perception). Thus, people that act before thinking, are thrill-seeking and irresponsible may take risks across many situations, including health risk behaviours.

Our findings are consistent with other research on psychopathy and risk taking with adolescent community samples. Increased risky sexual behaviours (particularly for female adolescents) were linked to higher levels of impulsive/irresponsible traits (Ručević, 2010). Similarly, higher levels of impulsive/irresponsible traits have been linked to more severe forms of alcohol use in adolescents. Importantly, regardless of current dependency levels, age or gender, adolescents with higher impulsive/irresponsible traits were more likely to increase their alcohol dependency six months later (Charalampous et al., 2019). Low self-control has robustly been linked to higher levels of crime and antisocial behaviour (Forrest et al., 2019). Previously, self-control was thought to be a stable and unidimensional concept (Gottfredson & Hirschi, 1990), however, more recently it is found to be multidimensional, including both risk-seeking and impulsivity and change throughout development (Forrest et al., 2019). Risk-seeking and impulsivity, two key elements of self-control, have been linked to the dual systems model (Steinberg, 2008) and maturation of differing brain and neurobiological systems.

In late adolescence, risk seeking continues to increase as brain areas involved in self-control and emotion regulation are maturing. In adolescence, then, there is a heightened propensity for risk-taking and potential engagement in crime (Forrest et al., 2019). The dual systems model (Steinberg, 2008) argues that from early to mid-adolescence, there is a sudden and dramatic surge in dopamine, driven by puberty. This rapid increase results in an increased drive to seek out novel, thrilling/exciting and varied experiences even if it means engaging in risk taking to obtain them (risk-seeking). This drive coupled with positive feedback in reward or sensations act as reinforcers. This socioemotional system is thought to hold some evolutionary advantage as the drive to seek reproductive success occurs simultaneously with puberty.

In contrast, the cognitive control system consists of the prefrontal cortex and is involved in higher order processing. The cognitive control system aids in controlling impulses and self-regulation. Of importance, it matures much slower than the socioemotional system continuing developing into mid 20s (Steinberg, 2008). Thus, impulsivity gradually declines as the prefrontal cortex matures and increases in speed, efficiency, and connectivity to other areas of the brain (Forrest et al., 2019).

People who are impulsive may find it difficult to expend attentional resources to consider alternative courses of action, plan ahead or weigh up risks and rewards. People who are high on impulsive psychopathic traits show greater reward seeking behaviour (Carver & White, 1994) and lower resting cortical arousal levels (Mathias & Stanford, 2003). Thus, they may seek stimulation in their environments to increase their arousal levels (Zhang et al., 2015). In a systematic review, people with impulsive-antisocial traits had activation of brain areas (Ventral Striatum) associated with the pursuit of rewards and risk-taking behaviours during the anticipation of rewards (Murray et al., 2018). Impulsive/irresponsible traits have also been associated with deficits in executive function abilities (Baskin-Sommers et al., 2015), poor inhibitory control (Pasion et al., 2018; Prata et al., 2019) and poor attention (Gao et al., 2018). Thus, people who are impulsive may engage in dangerous risk-taking behaviours and be more rebellious in general.

Does the interaction between risk skill ability and psychopathy affect risk taking (crashes, or rebellious risk taking), rebellious risk perception and risk preference?

Risk skill ability did not alter the relationship between psychopathy and crashes or rebellious risk taking, rebellious risk perception, nor risk preference. However, risk skill ability was associated with higher GCSE maths scores. Logical, analytical, and critical

thinking which are important for maths, may also be important for utilising a consistent strategy and thus high-risk skill abilities. It is possible that that risk skill ability is indirectly linked to risk taking via other processes or mechanisms such as executive function abilities. The organisation of executive functions includes both "hot" executive functions involving the control of emotional or reward-based stimuli and "cool" executive functions involving more cognitive processing (De Brito et al., 2013). Both forms of executive functions are associated with different brain regions (Nejati et al., 2018). Response control and attentional processes are associated with "hot" executive function regulation. In contrast, reasoning abilities, working memory and planning (De Brito et al., 2013; Poland et al., 2016); processes that are more 'logically' based (Chan et al., 2008) are associated with "cool" executive functions. Studies have found superior "cool" executive function abilities are associated with "successful psychopaths" (Baliousis et al., 2019). Thus, risk skill may be related to "cool" processes and therefore, may indirectly affect the relationship between psychopathy and risk taking.

Implications

The results of the present study highlight how important impulsive/irresponsible traits are to risk-taking behaviours around health risk taking (crashes and rebelliousness) and the perception of risk. Given that other studies have shown impulsive/irresponsible traits are linked with escalating dependency, particularly to alcohol/substance misuse (Charalampous et al., 2019), early detection of these traits is crucial. Individuals prone to engage in risk taking may suffer detrimental consequences such as unplanned pregnancies, alcohol dependency, injuries or infections that may impact other areas of life, for example, diminished engagement in education and a reduction in positive social networks (Muñoz and

colleagues 2008). Poor educational attainment is likely to result in limited job opportunities, increased levels of disadvantage in later life and lowered self-esteem (Moffitt., 1993; Vaughan et al., 2011). These adolescents may be characterised by making "bad choices" rather than being vulnerable. Adolescence is also a time where existing supports begin to diminish, and adult supervision declines, thus increasing opportunities for engaging in risk taking and negative peer interactions. Associating with peers also involved in high risk taking may further increase chances of escalating risk-taking tendencies. As risk-taking behaviours appear to cluster, negative consequences may create a cumulative burden over time for these adolescents.

By identifying these individuals early, it may be possible for parents, or teachers to channel risk-taking tendencies towards activities that build self-esteem, confidence, and self-control, preventing some of the adverse consequences later in life. Research shows that engagement in regular structured activities is related to various positive outcomes such as improved educational achievement (Cooper et al., 1999), reduced likelihood of drop out from school (Mahoney & Cairns, 1997) and reduced delinquency (Mahoney, 2000). However, compared to early adolescence, many adolescents stop engaging in unstructured activities preferring more unstructured settings such as loitering in public parks where risk-taking opportunities are higher. Persson et al (2007) found that adolescents with poorer relationships with parents and negative feelings about home along with peers in unstructured activities were more likely to switch to hanging out in parks or streets. Adolescents who never joined structured activities at all or quit or switched to hanging out in the streets were more likely to engage in delinquent behaviour. Importantly, the study showed some evidence that positive relationships with parents could be protective against increases in delinquency. Adolescents who switched to hanging out on the streets but whom also had good family relationships were less likely to engage in increased delinquent behaviour.

Thus, this has important implications for adolescents with impulse/irresponsible traits who are more likely to engage in high risk-taking behaviours. For these adolescents, it may be even more important that the home environment and parent relationships are positive with opportunities to feel valued, respected, and somewhat in control of their lives. This is a difficult balance to obtain for parents. To protect adolescents, parents may become overly controlling of their children's lives, resulting in more negative interactions that may drive adolescents towards more unstructured peer interactions. One potential avenue may be to encourage structured activities early in childhood that have some element of thrill seeking and prestige such as bouldering/rock climbing, martial arts or break dancing but where risk taking opportunities are limited and negative peer influences can be somewhat limited. This may enable competence, self-esteem, and self-management skills to be developed making it less likely that activities will be dropped and may develop skills that have a protective function even if adolescents switch to unstructured activities.

From a clinical perspective, to provide appropriate and effective interventions early and limit the adverse consequences, it is crucial to understand how each subdomain (and the interactions between them) affect behaviour. Thus, holding a multidimensional approach to psychopathy is imperative. Given that adult behavioural subdomains have also been linked to impairments in decision making and attention, (Fanti et al., 2016) interventions specifically aimed at targeting these deficits in adolescents may prove useful. Positive results have been observed from interventions aimed at reducing impulsivity such as "cognitive control training" (Peckham & Johnson, 2018) and mindfulness training (Salmoirago-Blotcher et al., 2019). Also, results from a meta-analysis investigating "No -go inhibition training" show notable improvements in overall health outcomes as well as alcohol use (Allom et al., 2016).

From a developmental perspective, it is also important to distinguish between adolescents with high sensation seeking and those who act before thinking (Romer et al.,

2017). Although both are associated with risk taking (Romer, 2010; Steinberg, 2008), and closely related constructs (Whiteside & Lynam, 2001), individuals with high sensation-seeking are less likely to experience addiction or problematic gambling compared to individuals with elevated impulsive traits (Khurana et al., 2017). Unlike people with impulsive traits, people with high sensation-seeking tendencies have good working memory abilities as well as good functionality in other areas of executive function (Romer et al., 2011; Zuckerman, 2007). Thus, although people with high sensation-seeking tendencies also engage in risk taking, they can learn from these experiences and exert cognitive control over their actions, whereas individuals with high impulsivity do not (Romer et al., 2017). Thus, if we are to identify the most vulnerable adolescents, it will be important to distinguish between adolescents with high sensation-seeking tendencies from high impulsive traits.

Limitations and Future Directions

The present study has some limitations, as do all studies. The present study was cross-sectional, so we cannot know the direction of effects for impulsive/irresponsible traits and risk taking. Using a longitudinal design with a cohort of children and early adolescents with high and low impulsive/irresponsible traits and then following them up into later adolescence may help to establish causal effects. Within the sample, young men were underrepresented, making up only 31% of the study sample. Moreover, a large proportion of the young men we recruited were from a Catholic sixth-form college. Research suggests that religious adolescents exhibit lower risk taking (Sinha et al., 2007). Thus, it is possible that strong religious beliefs may serve as a protective function against excessive risk taking and this may have had a confounding effect on results, since only the young men in our sample would have potentially been lower in risk taking. Schools/ colleges and sixth forms that took part in the

study were perhaps those that were already more psychologically minded and interested in psychology, mental health, and wellbeing. That is, we recruited through the psychology teachers at some of the schools. Thus, the study sample may not be entirely representative of the adolescent population.

Nonetheless, the study had many strengths and the findings contribute to the literature on the relationship between psychopathy and risk taking. The study sample was large, and we were able to recruit across seven different schools, colleges and sixth forms across different socio-economic areas. We were also able to use both behavioural measures of risk-taking (through crashes on a well-designed game) as well as frequency measures of real-life risk-taking (ARQ). Yet, it is difficult to know how these youths would drive in real-life since the Stoplight game did not have real negative consequences beyond a loud noise for crashes.

Future research should continue to explore the concept of risk skill in relation to psychopathy. One potential avenue would be to extend this study into adult populations using psychopathy measures that also include adaptive features within the conceptualisation of psychopathy such as the Triarchic Psychopathy Measure (Patrick, 2010). Another possibility would be to test the hypothesis that risk skill ability is indirectly related to risk taking. Exploring the association between "hot" and "cold" executive functions and risk skill ability may help to further explain why some people are able to channel their risk taking tendencies to more positive means. Having a better understanding of the neural processes or mechanisms underpinning risk skill abilities may improve interventions.

Summary

The present study is the first to examine the role of risk skill with psychopathy and risk taking in an adolescent sample. Risk skill ability was related to grandiose/manipulative

traits, however, did not moderate the relationship between psychopathy and different aspects of risk-taking. Elevated grandiose/manipulative traits showed some promising links to risk skill ability that may warrant further exploration in future research. The most striking finding was that adolescents with elevated impulsive/irresponsible traits were consistently associated with higher risk taking across various measures (more crashes on the driving task, higher levels of self -reported rebellious risk taking) and perceived rebellious risks as less risky compared to adolescents with lower impulsive/irresponsible traits.

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Appendix A

Figure 1

Ethics Approval Letter

UNIVERSITY OF LIVERPOOL

Central University Research Ethics Committee B

19 September 2019

Dear Dr Centifanti

I am pleased to inform you that your application for research ethics approval has been approved. Application details and conditions of approval can be found below. Appendix A contains a list of documents approved by the Committee.

Application Details

Reference:	4609
Project Title:	Decision making and risk taking in adolescents
Principal Investigator/Supervisor:	Dr Luna Centifanti
Co-Investigator(s):	Miss Valerie Hawke, Dr Minna Lyons
Lead Student Investigator:	-
Department:	Department of Clinical Psychology
Approval Date:	19/09/2019
Approval Expiry Date:	Five years from the approval date listed above

The application was **APPROVED** subject to the following conditions:

Conditions of approval

- All serious adverse events must be reported to the Committee (ethics@liverpool.ac.uk) in accordance with the procedure for reporting adverse events.
- If you wish to extend the duration of the study beyond the research ethics approval expiry date listed above, a new application should be submitted.
- If you wish to make an amendment to the study, please create and submit an amendment form using the research ethics system.
- If the named Principal Investigator or Supervisor changes, or leaves the employment of the University during the course of this approval, the approval will lapse. Therefore it will be necessary to create and submit an amendment form within the research ethics system.
- It is the responsibility of the Principal Investigator/Supervisor to inform all the investigators of the terms of the approval.

Kind regards,

Central University Research Ethics Committee B

ethics@liverpool.ac.uk

0151 794 8290

Appendix - Approved Documents

(Relevant only to amendments involving changes to the study documentation)

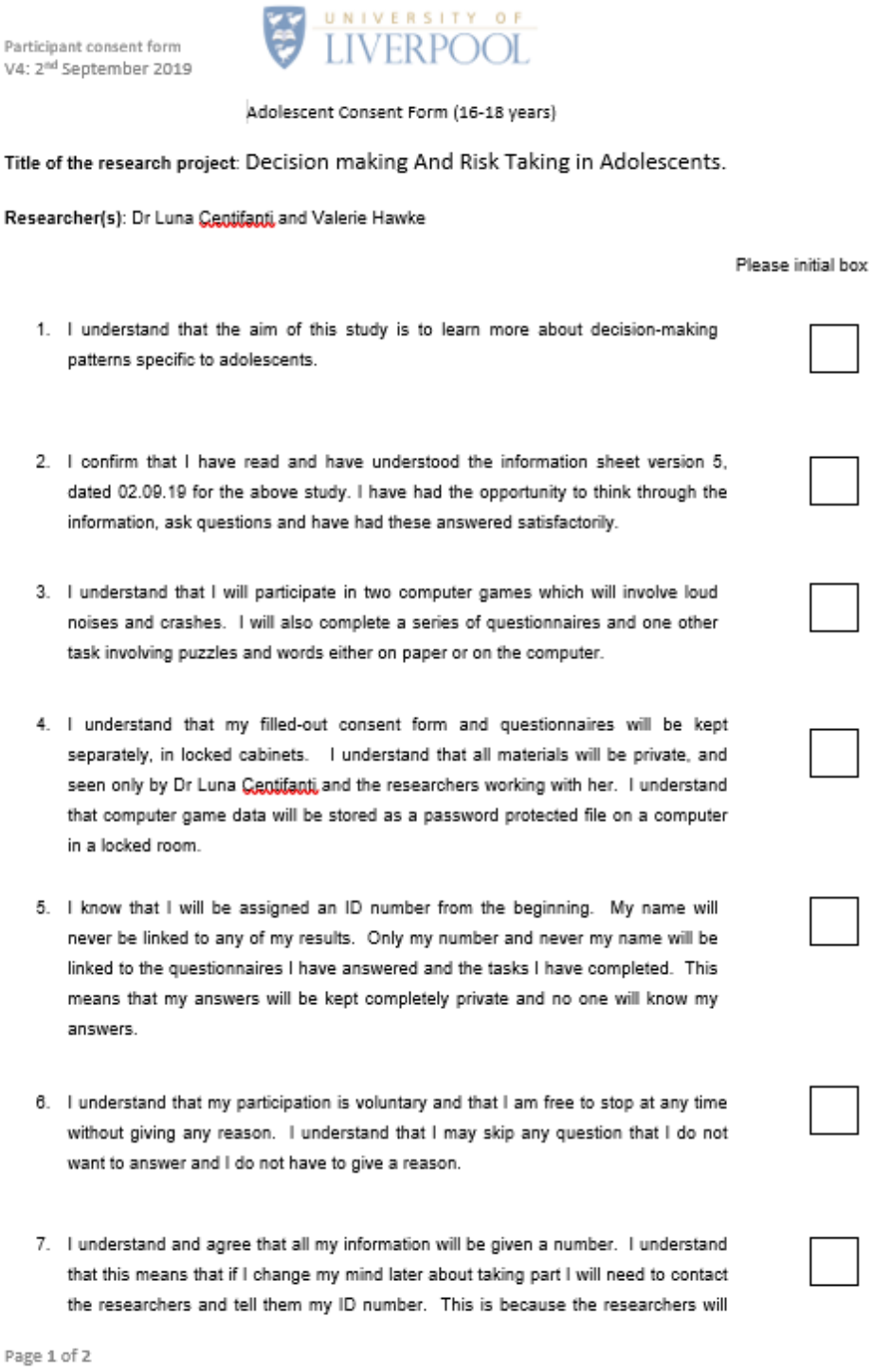
The final document set reviewed and approved by the committee is listed below:

Document Type	File Name	Date	Version
Risk Assessment	Generic,Risk,Assessment,-,Classrooms,Teaching,room,&,LTs	01/11/2016	3
Evidence Of Peer Review	Hawke Valerie_Approval	17/09/2018	5
Questionnaire	YPI-english-1	05/02/2019	1
Questionnaire	ARQ- V1 (22 items)	05/02/2019	1
Questionnaire	BASC 3 Self Report SRP	27/02/2019	1
Advertisement	flyer risk-taking study v2	28/05/2019	2
Questionnaire	Demographic Questionnaire v4- 02.09.19	02/09/2019	4
Participant Information Sheet	Information sheet. adolescents v5 02.09.19	02/09/2019	5
Participant Consent Form	Adolescent Consent Form v4 02.09.19 (1)	02/09/2019	4
Participant Information Sheet	Information sheet. adolescents v5 02.09.19	02/09/2019	5
Debriefing Material	YP Debrief Sheet V2	08/09/2019	2
Participant Consent Form	Adolescent Consent Form v4 02.09.19 (1)	08/09/2019	4
Advertisement	Letter to Headteacher v4 11.09.19	11/09/2019	4

Appendix B

Figure 2

Adolescent consent form



Participant consent form
V4: 2nd September 2019

UNIVERSITY OF LIVERPOOL

Adolescent Consent Form (16-18 years)

Title of the research project: Decision making And Risk Taking in Adolescents.

Researcher(s): Dr Luna Centifanti and Valerie Hawke

Please initial box

1. I understand that the aim of this study is to learn more about decision-making patterns specific to adolescents. ☐
2. I confirm that I have read and have understood the information sheet version 5, dated 02.09.19 for the above study. I have had the opportunity to think through the information, ask questions and have had these answered satisfactorily. ☐
3. I understand that I will participate in two computer games which will involve loud noises and crashes. I will also complete a series of questionnaires and one other task involving puzzles and words either on paper or on the computer. ☐
4. I understand that my filled-out consent form and questionnaires will be kept separately, in locked cabinets. I understand that all materials will be private, and seen only by Dr Luna Centifanti and the researchers working with her. I understand that computer game data will be stored as a password protected file on a computer in a locked room. ☐
5. I know that I will be assigned an ID number from the beginning. My name will never be linked to any of my results. Only my number and never my name will be linked to the questionnaires I have answered and the tasks I have completed. This means that my answers will be kept completely private and no one will know my answers. ☐
6. I understand that my participation is voluntary and that I am free to stop at any time without giving any reason. I understand that I may skip any question that I do not want to answer and I do not have to give a reason. ☐
7. I understand and agree that all my information will be given a number. I understand that this means that if I change my mind later about taking part I will need to contact the researchers and tell them my ID number. This is because the researchers will ☐

Page 1 of 2

not be able to identify what information belongs to me from my name.

8. I understand that I will only be able to withdraw from the study until December 2019 because after this date, the researchers will be analysing the data. ☐

9. I understand that if the tasks or questionnaires trigger or bring up any concerns or worries about the way I have been feeling or what I have been doing, I will be given a debrief sheet at the end of the study with information about what I can do. ☐

10. I agree to take part in the above study. ☐

_____	_____	_____
Participant name	Date	Signature
_____	_____	_____
Name of person taking consent	Date	Signature
_____	_____	_____
Researcher	Date	Signature

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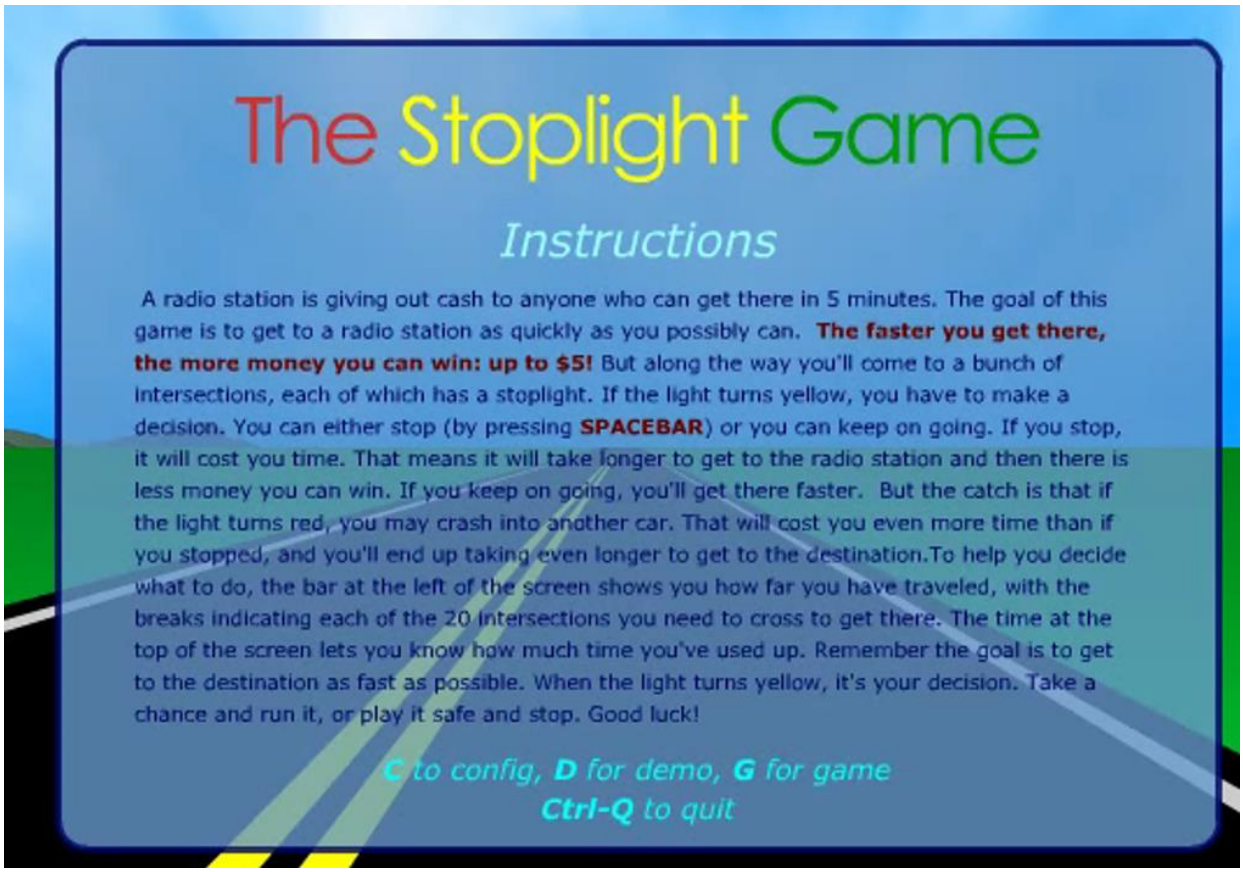
Appendix C

Figure 3

Stoplight Participant Instructions



Appendix D

Table 1

A comparison of the study sample mean and standard deviation scores for ARQ subscales as a function of age and gender compared to data from Gullone et al., (2000).

		Age		**Gender**			
		15 to 18 Years Old	**15 to 19 Years Old**	**Boys**		**Girls/other gender**	
Adolescent Risk Taking Questionnaire (ARQ)	possible range	Gullone et al., 2000 M (SD)	Study sample set M (SD)	Gullone et al., 2000 M (SD)	Study sample set M (SD)	Gullone et al., 2000 M (SD)	Study sample set M (SD)
Behaviours							
Rebellious	0 - 4	1.60 (1.00)	1.9 (1.03)	1.34 (1.04)	1.62 (0.95)	1.32 (1.00)	2.02 (1.04)
Perceptions							
Rebellious	0 - 4	2.35 (1.01)	1.76 (0.56)	2.85 (1.03)	1.75 (0.51)	2.58 (0.95)	1.77 (0.58)

Appendix E

Table 2

Mean and standard deviations for the Youth psychopathic trait inventory (YPI) as a function of gender; a comparison of the study sample against other research.

Youth psychopathic trait inventory		Andershed et al., 2007 Male adolescents (Mage=16.8 years)		Somma et al., 2018 Male adolescents (Mage =16.3 years)		Sample set Male Adolescents (Mage=16.74 years)	
	possible range	**N**	**M (SD)**	**N**	**M (SD)**	**N**	**M (SD)**
Total Score	1-4	70	2.39 (0.4)	146	1.88 (0.42)	88	2.23 (0.4)
Grandiose-Manipulative scale	1-4	70	2.15 (0.6)	146	1.74 (0.59)	93	2.09 (0.6)
Callous-Unemotional Scale	1-4	70	2.25 (0.6)	146	1.9 (0.41)	89	2.13 (0.5)
Impulsive-Irresponsible Scale	1-4	70	2.78 (0.4)	146	2.06 (0.52)	94	2.47 (0.5)

Youth psychopathic trait inventory		Andershed et al., 2007 Female adolescents (Mage=16.8 years)		Somma et al., 2018 Female adolescents (Mage =16.3 years)		Sample set Female/other gender (Mage=16.74 years)	
	possible range	**N**	**M (SD)**	**N**	**M (SD)**	**N**	**M (SD)**
Total Score	1-4	92	2.29 (0.4)	432	1.65 (0.37)	208	1.96 (0.4)
Grandiose-Manipulative scale	1-4	92	1.99 (0.6)	432	1.43 (0.47)	212	1.81 (0.5)
Callous-Unemotional Scale	1-4	92	2.00 (0.5)	432	1.64 (0.40)	214	1.67 (0.4)
Impulsive-Irresponsible Scale	1-4	92	2.87 (0.5)	432	1.97 (0.53)	212	2.45 (0.5)

Note: Andershed et al (2007) sample consists of youths with substance misuse problems. Somma et al (2018) participants are a community based sample.

Appendix F

Table 5

Breakdown of missing data for study variables

	Missing Data	Total data	Percentage
Demographic data			
School	0	313	0%
Age	0	313	0%
Female	0	313	0%
Ethnicity	3	313	1%
Money	23	313	7%
P_Home_Owners	24	313	8%
M_Education	48	313	15%
F_Education	76	313	24%
Drivers_Licence	0	313	0%
Driving_Lessons	12	313	4%
GCSE_Maths	1	313	0%
GCSE_English	1	313	0%
Youth Psychopathic Inventory (YPI)			
YPI_GM	8	313	3%
YPI_CU	10	313	3%
YPI_II	4	313	1%
Adolescent risk taking questionnaire (ARQ)			
Thrill-seeking risk taking	10	313	3%
Reckless risk taking	11	313	4%
Rebellious risk taking	10	313	3%
Antisocial risk taking	11	313	4%
Thrill-seeking risk perception	4	313	1%
Reckless risk perception	3	313	1%
Rebellious risk perception	3	313	1%
Antisocial risk perception	3	313	1%
Risk skill Task			

Risk skill (consistency)	14	313	4%
Risk preference	14	313	4%
brakes	13	313	4%
crashes	13	313	4%
Overall missing data	319	8451	4%